ENTOMOLOGICAL
SOCIETY OF
BRITISH COLUMBIA

PROCEEDINGS

OF THE

ENTOMOLOGICAL SOCIETY

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JULY, 1913

NUMBER 3, N. S.

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THE PROVINCE OF BRITISH COLUMBIA

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TABLE OF CONTENTS.

	PAGE.
Entomology from the Standpoint of a Botanist—J. Davidson, F.L.S., F.B.S.E...	5
Combination Sprays—H. F. Wilson	9
Economic Side of Pest-control—R. M. Winslow	17
Insect Records in the Field—R. C. Treherne	21
Work of the Inspector of Fruit Pests—Thos. Cunningham	24
Importance of Economic Entomology—M. H. Ruhman	27
Presidential Address	29
Problems of Aphis-control—L. L. Palmer	31
Two Insects attacking Peach—W. H. Lyne	34
Cutworms and their Control—M. S. Middleton	36
Economic Ornithology—Lionel E. Taylor, F.Z.S., M.B.O.U.	37
Canadian Ipidæ—J. M. Swaine	41
Resolution	43
Index	45

BRITISH COLUMBIA ENTOMOLOGICAL SOCIETY.

MIDSUMMER MEETING, 1913.

THE first midsummer, semi-annual meeting of the British Columbia Entomological Society was held in the Court-house, Vernon, B.C., on July 18th and 19th, 1913. Between fifty and sixty individuals were present at the meetings during the session, and these included representatives from Vancouver Island, Lower Mainland, Salmon Arm, Kootenay, and Okanagan Districts. The President, Mr. G. O. Day, of Duncan, was in the chair, and the meeting was called to order at 1.45 p.m. on July 18th, 1913.

The President: I am very pleased indeed to see the splendid number of enthusiasts present here to-day at this opening meeting of the first special semi-annual gathering of this Society. I will reserve my few words of welcome to a later occasion on the programme and, without further delay, will ask Mr. John Davidson, Provincial Botanist, to present his paper on "Entomology from the Standpoint of the Botanist."

ENTOMOLOGY FROM THE STANDPOINT OF A BOTANIST.

By J. Davidson, F.L.S., F.B.S.E., Provincial Botanist.

In the course of one's botanical experience there are many occasions when some knowledge of entomology is absolutely necessary, just as to the entomologist it is necessary to know something about plants. In the short time at my disposal I propose to summarize the interrelationship of plants and insects, and if I can stimulate some of those present to make observations and notes of the interrelationships which are to be seen in our own Province, I shall be glad to render them further assistance and obtain their co-operation.

Insects spread Plant-diseases.

It is well known that insects play a very important part in the distribution of disease, and it must be remembered that most of our contagious and most dreaded diseases belong to the vegetable kingdom. In addition to bacteria, mould, and other fungi carried by contact, we find that insects such as some of the Diptera suck the putrid deliquescent mass of spore-tissue of such fungi as belong to the Phallineæ (the Stinkhorn Fungus family) and other groups. This fluid is charged with myriads of minute spores which pass uninjured through the insect, and are distributed in its excreta.

Claviceps purpurea, the ergot fungus which attacks rye and other grasses, is similarly distributed, the fungus forming a sweetish fluid, attractive to flies. During their visits the flies are liberally smeared with spores, and these on being carried to healthy grasses spread the disease.

We do not find, however, that insects are much interested in the benefit done to the fungus in spreading its spores, or in the injury done to the host in spreading the disease. The insect is more concerned about the maintenance of the individual and the propagation of its species.

In connection with the egg-laying operations of insects, there is much that is interesting regarding the indirect results. For example, some of the Coleoptera are

held responsible for much of the larch-disease (*Dasyscypha wilkommii*). Beetles in boring or inserting the ovipositor into the fungus-infested tissue of diseased trees carry the minute ascospores to healthy trees and set up infection there, just as mosquitoes are believed to carry infection from one human being to another.

INSECTS PRODUCE MALFORMATIONS.

Again, the *Cecidomyia* and other gall-forming insects cause the formation of wonderful and often beautiful structures on the leaves and branches of many of our native plants. This subject is much in need of working-up. What plants do you find galls on? What insect is responsible for each? Does one species of insect produce galls on more than one species of plant? If so, are the resulting malformations similar? It is interesting to examine the structure of these galls and note the abnormal growth which has taken place, compared with the natural growth of an unaffected part. It is believed that when the egg is deposited a little fermentive fluid is exuded which stimulates the cells in the immediate neighbourhood to absorb more nourishment; this nourishment is absorbed by the young larva, which is capable of stimulating a larger number of cells to ultimately form these curious malformations known as galls.

INSECTS DESTROY MUCH VEGETABLE LIFE.

As to the depredations of the larvæ of butterflies and moths, sawflies, etc., the systematic botanist is perhaps not so severe as the economic entomologist. These insects require food, just as our cattle and horses do. Insects may be responsible for the destruction of much vegetable life, but man himself is the greatest of all sinners in this respect. Nevertheless, the botanist is interested in the causes which lead up to these depredations, which come home to him in other ways besides the increased cost of living.

We find that in nature such depredations leave us with a greater proportion of plants more able to resist attack, and if insects prefer cultivated plants rather than native plants, it is because the cultivated ones are unnatural, abnormal. Indeed, to the systematic botanist, most of our farm and orchard crops are freak specimens, which, on account of their long isolation from their natural environment, are less able to resist the attacks of their natural enemies, and without the aid of man to keep them as they are they would revert to their natural condition, or become exterminated altogether.

BATTLE BETWEEN PLANTS AND INSECTS.

All through nature we have this constant battle between plants and insects. It is not a one-sided battle; sometimes the insects win, and sometimes they lose.

Insects win.—Most people are familiar with the depredations of caterpillars, and many believe that the vegetable kingdom is pretty much at the mercy of the animal kingdom, but this is not so. We are all dependent on the vegetable kingdom, and seeing that the plant world has supported the population of the animal world for many thousands of years, it is only natural that insects should select the best food they can get from the enormous menu at their disposal.

Plants win.—Comparatively few people, however, are familiar with the depredations of plants on insects. Take, for example, the common house-fly. One of the most deadly diseases of this far too common insect is a fungus known as *Empusa muscæ*. In the north of Scotland, where this is common, I have seen within an area of two or three square yards hundreds of dead flies attached to the stems and leaves of small plants such as grasses and shepherd's purse.

The spores of this fungus are extremely small, and have a viscid coat around them. They are shot off from the ends of minute fungus-threads, and float about readily in the air. If one should come into contact with a fly, it sends a small sucker into its body and gradually begins to grow in the interior of the insect. Finally, the fly becomes weakened and settles down to rest; the fungus then pushes

out a whole mass of fine threads and fastens the fly to its last resting-place. From a layer of fungus-threads all over the body of the fly thousands of these minute spores are again shot into the atmosphere, until all the food substance in the fly is exhausted.

Some of you may have seen a dead fly on the window-pane with a halo of white around it; this halo is composed of the many threads of fungus-hyphæ fixing the fly to the glass, while it liberates its spores.

I presume that most of those present have reared larvæ of Lepidoptera. Have you ever found that some of those larvæ which pupate in soil did not go through their whole metamorphosis, but died in the pupa stage; that on the pupa a white coat appeared accompanied by minute outgrowths? This is another plant known as *Isaria*, whose spores are found in some soils. The larva when attacked is usually not killed until after it has pupated.

There are other insect-diseases of equal interest; perhaps the most curious one is what has been popularly termed the "vegetable caterpillar." This, it is explained, is an organism which at one stage of its life is actually a creeping caterpillar, and at another stage is a plant, having a root in the ground and a stem bearing fruits above the ground.

This marvellous creation is in reality a caterpillar attacked by a disease known as *Cordyceps militaris*, a fungus closely allied to *Claviceps* (the ergot-disease of grasses). In this case, however, the fungus fills up all the available space inside the caterpillar without destroying the vital organs, and the caterpillar grows to practically its full size. When it descends into the soil to pupate, the fungus kills it, and proceeds to absorb all the remaining food material. This results in the whole interior being filled by a hard woody substance composed of fungus-threads.

Later on, from one end of what was a caterpillar, a stem-like structure grows to a few inches above the surface of the ground, and this bears thousands of spores which lie about, or are blown from place to place, infecting other larvæ.

This particular species of *Cordyceps* is common in New Zealand, but is found, along with several other species, in North America.

PARASITISM V. INTRODUCTION OF DISEASE.

We have heard a good deal about parasitism as a means of combating orchard pests, but I am always sceptical as to the ultimate result of introducing new species of animals into a country, and more particularly when you introduce one lot to get rid of another.

By introducing other insects, you are introducing the food of other animals which prey on these. There is a risk of nature restoring the balance by the increase of insectivorous birds, and, as is well known, birds are recognized agents in spreading disease and insect pests, so that we may ultimately find ourselves worse in the end than we were at the beginning.

As I already mentioned, the majority of our most dreaded contagious diseases belong to the vegetable kingdom. It would be interesting to see what could be done in introducing parasitic fungi to combat insect pests. The introduction of disease amongst rats has been responsible for great havoc in reducing their numbers, and we may yet be able to treat our insect pests in a like manner.

FRIENDSHIP BETWEEN PLANTS AND INSECTS.

In the midst of the battle between plants and insects, let us not forget that there are many friendships. There is some good business transacted between the two kingdoms. I need only refer to the arrangement existing between certain insects and certain flowers, whereby the insect acts as a pollen-bearer in return for the nectar which the flower provides.

I cannot possibly enter into the various schemes, devices, and dodges adopted by flowers to attract certain insects and keep out others; this would take several days.

But I should like to refer to some very interesting partnerships where not only a temporary acquaintance is made with each other, but where both insect and plant have found it to their mutual advantage to live friendly.

ANTS PROTECT PLANTS.

Perhaps the most outstanding example is to be found in Mexico. The mere mention of that country may give a clue to the reason for the partnership. In Mexico there is an *Acacia* (*Acacia sphærocephcla*) which is subject to the attacks of herbivorous quadrupeds. A common means of protection against these has been adopted by converting the stipules into spines. This not being sufficient, an arrangement has been made for a fierce race of stinging-ants to act as a standing army, which the *Acacia* has undertaken to keep, in peace or war.

The ants pierce the bases of the spines and eat out the interior; this stimulates the spines to increase in size, sufficient to accommodate several of these soldiers in each cavity. The *Acacia* has compound pinnate leaves, and at the tips of the leaflets small grain-like food-bodies are produced. The ants are continually running over the plant attending to these, picking and eating them when matured.

In addition to free board and lodgings, the ants are provided with free drinks, in the form of nectar exuded by minute saucer-shaped nectaries borne on the midrib of the leaf.

Altogether, the ants have some reason to defend this hospitable *Acacia*, and, in return, unwelcome visitors are accorded such a warm reception that it has proved a quite successful means of defence.

PLANTS PROTECT ANTS.

In tropical forests ants often find difficulty in keeping their accumulations of debris together on account of the liability of being washed away by heavy rains. These heaps are usually formed on the branches of trees because the surface of the earth is more or less swampy, but the ants have found that by including seeds and small portions of certain plants an abundance of roots ramify throughout the heap, and help to keep it together; whilst the mass of foliage covering it is sufficient to break the force of the rain, or help in diverting it from the ant's home. We find that many plants grow best in such situations, and on this account are included amongst the myrmecophilous, or ant-loving, plants.

One genus of plants, round in Malacca and New Guinea, has been named *Hydnophytum formicarum* on account of its symbiotic relationship with ants. The plant is epiphytic (living on the branches of trees), and at an early stage in its development it is attacked by black ants, who eat their way into the tuber. Ultimately a large irregular-shaped ball-like structure develops, through which a whole mass of galleries and passages ramify and anastomose, serving as a home with many doors for entrance and exit. One can readily understand that the tuber now transformed into an ant's nest will be well looked after by the inhabitants.

INGENUITY OF METHODS OF HIGHER PLANTS.

I can only briefly refer to the insectivorous plants, and if I had time to describe the ingenious traps of *Dionœa*, *Nepenthes*, *Utricularia*, *Drosera*, and others, I think you'd agree that truth is certainly stranger than fiction.

To hear how some plants set miniature rat-traps to instantaneously capture insects; how others tempt insects by intoxicating fluid, and that when under its influence they are drowned and utilized as food; how other plants lure the unwary insect to partake of an imaginary feast only to find that the apparent drops of nectar were viscid glands on the ends of sensitive hairs which, like the arms of a gigantic octopus, envelop the struggling creature, I am sure you'd agree that their ingenuity would be hard to beat.

Many of the methods adopted by plants to prevent undesirable insects are well known, but there are many of our native plants which deserve to be more fully studied, in order to ascertain the full relationship between the entomologist and the botanist.

OPPORTUNITIES FOR ENTOMOLOGIST AND BOTANIST.

We want to know what insects are responsible for the pollination of our native plants, and what are the food-plants of their larvæ. I feel that in this particular subject much good work might be done by the co-operation of entomologist and botanist. We may see other parts of the subject from different standpoints, but it is good for us to occasionally meet on the same ground, to compare notes, with the hope that our observations may be mutually beneficial.

Mr. T. Wilson: In regard to the relation of the animal to the vegetable kingdom, in one of Darwin's writings we find that he claims that the success of the clover-crop depends on the number of cats in the district. He deduces that crops most abundant in seed occurred near villages, and that the crops were lightest some distance away. He found that the cats killed the mice, the mice destroyed the bumble-bees' nests, and as the bees were necessary to fertilize the clover, consequently the crop depends on the number of cats. Mr. Davidson also mentioned the relation of insects to plants. I remember some experiments that were carried on in regard to insectivorous plants. They took the Venus fly-trap in order to prove its carnivorous habits. Seedlings were raised, some under bell glasses, some open, and some were fed beef and scraps. The result of the experiment proved that the carnivorous diet was merely an acquired habit.

Mr. Brittain: The disease known as fire-blight is well known to be carried by insects. Bees are perhaps the greatest factor. I have found centres of blight-infestation in very isolated spots well away from other districts already infested to a marked degree. Birds will also carry the disease, for we find the blight occurring at points geographically isolated. The green aphis also spreads the disease on trees from fruit-spurs to the twigs. The apple-leaf hopper (*Empoasca mali*) is another medium of spread. Many wound-parasites, such as flies, etc., also help to spread the disease.

The Chairman (Mr. Day): Any further remarks? Before closing, I would like to say that on Vancouver Island we find many caterpillars affected with fungous diseases. The same also with ground-insects. I will now call on Professor Wilson, who has come to us to-day from the Corvallis Agricultural College in Oregon. I take great pleasure in welcoming him here to-day and introducing him to the members present.

COMBINATION SPRAYS AND RECENT INSECTICIDE INVESTIGATIONS.

BY H. F. WILSON, ENTOMOLOGIST, OREGON AGRICULTURAL EXPERIMENT STATION, CORVALLIS, OREGON.

Mr. Chairman, Members of the British Columbia Entomological Society, and Friends,—It is indeed a pleasure for me to be able to meet with you at this time, and I wish to publicly thank Mr. Brittain, your Provincial Entomologist and Plant Pathologist, who so kindly extended to me the invitation to attend this meeting. Mr. Brittain also kindly suggested my subject for me, and he tells me that it is one in which you are intensely interested.

COMBINATION SPRAYS AND RECENT INSECTICIDE INVESTIGATIONS.

I deem it advisable to explain in general and in detail the factors which have led to the study of this subject.

(1.) I consider this to be the most important problem before the farmers and fruit-growers of to-day.

(2.) For some one or more reasons not clear to us, our knowledge of sprays and their effects is very unsatisfactory.

(3.) While our commercial insecticides are more or less stable, under certain ideal conditions the results obtained from their use are too variable for us to make definite and well-defined recommendations.

(4.) The economy of spraying and the numerous new sprays on the market at the present time demand an entirely new investigation of the subject.

OUTLINE OF EXPERIMENTS.

With these facts in view the following series of experiments have been outlined:—

(1.) Knowing that certain sprays are effective when used alone, to determine what ones may be successfully combined without lessening insecticide values.

(2.) Having effected the combination of certain sprays, to determine, if possible, the factors that govern successful application with a minimum of injury to fruit and foliage and at the same time give a maximum of protection.

COMBINATION SPRAYS.

During the last few years the economy of proper plant-protection has become a problem of great importance to the farmer and fruit-grower. We have well-known insecticides and fungicides which are quite effective in the control of different pests, but in order to be effective they must be applied at the proper time. Every pest has a distinct life-history method of development and manner of attacking its host or hosts. These factors in most cases determine the method of treatment and time of application.

In former years the number of standard sprays for insect pests or fungous diseases was very limited, and combination or mixed sprays were practically unknown. With the development of the fruit-growing industry the number of important pests increased, and at the same time more elaborate methods of control became necessary.

The time of application of a spray for a fungous disease often coincides with the time of application for some one or more important insect pests. This has led to many experiments in the combining of insecticides and fungicides to determine the practicability of applying two or more sprays at the same time, instead of making separate applications of each. Considerable success has resulted from these experiments, and the combining of a fungicide and an insecticide or two insecticides is now a common orchard practice of considerable value to the fruit-grower.

However, many complications have arisen in the work, and while many general conclusions have been upheld, combination sprays are very unstable and many details are yet to be worked out. The greatest difficulty arises from the fact that arsenic is the base of nearly all poison insecticides. Free arsenic will cause great injury to foliage, and in order to use it some insoluble compound is necessary. In the form of lead-arsenate, when properly prepared, arsenical sprays can be applied with a reasonable degree of safety, but in combination with other compounds the nature of the original arsenical may be easily changed and free arsenic liberated. A very important factor is also found in that lime-sulphur and Bordeaux mixture, the two most important fungicides, are liable to cause spray injury when used alone, and arsenates or arsenites are very apt to accentuate this danger. Climatic conditions are also supposed to enter more or less into the serious injury that sometimes happens from the use of these sprays.

Some experimenters have claimed that in the combining of lime-sulphur and arsenates of lead certain chemical reactions take place which impair the efficiency of both. As there seemed to be no published data on experiments which might throw light on this subject, the Departments of Plant Pathology and Entomology of the Oregon Agricultural College undertook in 1912 to make a series of experiments which would at least show some indication as to the relative combative effects of

combinations of lime-sulphur and acid arsenate of lead, lime-sulphur and neutral arsenate of lead, and lime-sulphur and arsenite of zinc. These experiments were to be continued through three seasons in order to get checks on all data.

Several factors entered to interfere with the first season's work, so that the results were very unsatisfactory and detailed data is not worth mentioning. In going over the notes at the end of the season, however, several interesting facts were noted and are here summarized.

(1.) Lime-sulphur 29.5° Be. (1-30) + acid arsenate of lead 2 lb. to 50 gallons did not cause any more spray injury to foliage and fruit than did the lime-sulphur and neutral (spray injury was quite bad on Newtowns and Ben Davis). Injured fruit was worst on south side of tree and in direct rays of sun.

(2.) Lime-sulphur 29.5° Be. (1-30) + arsenite of zinc 1 lb. to 50 gallons (two different brands) did not cause but very little injury to foliage, and except in the case of Ben Davis did not cause any more injury to the fruit than was found on unsprayed trees. (Ben Davis suffered badly.) The injured fruit on these trees was worse on south side of tree.

(3.) Injured apples similar to those on the sprayed trees could occasionally be found on unsprayed trees in the check plot, but the difference in percentage was so great that we must conclude that the injury on the sprayed trees had in some way been caused by the spray.

In 1912, in connection with the above experiments, a series of experiments were started upon the decomposition of combined sprays when allowed to stand. The materials in each case were kept in corked bottles and examined from time to time during the following year. Apparently no further change occurred and each combination retained its characteristic odour. An examination on June 1st, 1913, gave the same conditions and tests for the insecticidal values and showed them to be apparently as efficient as freshly prepared materials.

Observations for the present season's work show some startling results, and on account of this a number of them were immediately checked. The same results were obtained in both cases.

The arsenates of lead used in these experiments were specially prepared by the Station Chemist, and were, according to methods of determination that will be published in the near future, theoretically pure.

The lime-sulphur was known as the Dependable Brand, made at Salem, Ore., and when analysed was found to be satisfactory in every particular. The arsenite of zinc used was manufactured by the California Spray Co., at Watsonville, California.

To determine the effect upon apple-foliage of the above chemicals alone and in combination, a series of experiments were conducted as follows: A block of twenty Newtown apple-trees was taken and each tree was used for one spray.

In 1913, under press of other work, the Department of Plant Pathology discontinued their part of the work, and so the investigations this year have not included the study of fungicidal values.

The Experiments were as follows:—

Experiments on the Decomposition of Combined Sprays when allowed to stand.
** Sprays combined as follows on May 29th, 1912. Lime-sulphur used in these Experiments tested 28.75 Be.*

(1.) Lime-sulphur ..... 17.5 cc. Black Leaf 40, 1-1,000..482.5 cc. Arsenate of lead, non-acid (C.S. Co.)..... 2.4 gms. C.S. Co. — California Chemical Spray Co., Watsonville, Cal.	May 29th. Combined the above materials on morning of this date. At 3 p.m. residue settled in bottom, changed from white to a grey. The odour of the Black Leaf 40 and the lime-sulphur are readily distinguished. The solution retained its amber colour and resembled lime-sulphur diluted to the same

* Materials combined at the rate of: Lime-sulphur 1 to 30; arsenicals at 2 lb. to 50 gallons for neutral and 1 lb. to 50 gallons for the arsenate of lead acid and the arsenite of zinc.

	strength, except that it appears slightly muddy or cloudy. The arsenate of lead settles faster than the residue from the Black Leaf 40, and the latter settles on top of the first in a flocculent blackish mass. June 1st. Liquid colour of dilute lime-sulphur. A considerable amount of free sulphur thrown down. A strong smell of both Black Leaf 40 and lime-sulphur still present.
(2.) Lime-sulphur ..... 17.5 cc. H_2O .....482.5 cc. Arsenate of lead, non-acid (C.S. Co.)..... 2.4 gms.	May 29th. Combined the above materials to get data on reaction and to find unsatisfactory results if any be present. This solution appears identical to that of Ex. (1), except muddy colour. June 1st. Solution colour of dilute lime-sulphur. A small amount of free sulphur thrown down.
(3.) Lime-sulphur ..... 17.5 cc. H_2O .....482.5 cc. Arsenate of lead, acid (C.S. Co.) ..... 2.4 gms.	May 29th. Combined the above materials to get data on reactions; also to note any visible effect of decomposition of the materials. The arsenate of lead a white paste changed to a black-grey colour and more residue is apparent than in the case of the neutral arsenate. The liquid or solution remains cloudy and muddy after several hours' standing. A decided difference between the colour of the residue in this solution and that of Exs. (1) and (2) is apparent. The residue is blacker in this solution. June 1st. Liquid colour of dilute lime-sulphur in addition to a large amount of black precipitate. A small amount of free sulphur is present.
(4.) Lime-sulphur ..... 17.5 cc. Black Leaf 40, 1-1,000..482.5 cc. Arsenate of lead, acid (C.S. Co.) ..... 2.4 gms.	May 29th. Combined the materials in this experiment to find the resultant reactions and to get data on the effect of the different materials. Everything is similar to Ex. (3), except that the residue from the Black Leaf 40, which was not placed in Ex. (3), is slowly settling on the arsenate of lead, which has already settled to the bottom. When Black Leaf 40 and lime-sulphur are combined, a fine precipitate slowly settles out. The nature of this is unknown to us at the present time. June 1st. Liquid colour of dilute lime-sulphur. A considerable amount of a yellowish-black precipitate has been thrown down in addition to the dark-grey arsenate of lead residue. This mixture seems to be a combination of free sulphur and the lime-sulphur+nicotine-sulphate residue.
(5.) Lime-sulphur ..... 17.5 cc. H_2O .....482.0 cc. Arsenate of lead, acid (Vreelands) ..... 1.2 gms.	May 29th. Combined the above materials to get data on effects and also to note any apparent decomposition. After settling for several hours the solution differed very little from a similar dilute solution of straight lime-sulphur and water, except that there was a slight cloudiness. The residue was a very black-grey with minute particles of sulphur scattered through it. June 1st. Liquid colour of dilute lime-sulphur. A very small amount of free sulphur has been thrown down on top of the black residue.
(6.) Lime-sulphur ..... 17.5 cc. Black Leaf 40, 1-1,000..482.5 cc. Arsenate of lead, acid (Vreelands) ..... 1.2 gms.	May 29th. Combined above materials to get data on effect of combination and to note any decomposition of materials which might take place. There is a difference of colour in the

	solution of this experiment, due to the suspended particles of residue formed by the Black Leaf 40 and lime-sulphur. Some of this residue has already settled, but apparently not all. The arsenate of lead, which is a dirty black, settled first and the other settled on top of it. June 1st. Liquid colour of dilute lime-sulphur. A considerable amount of free sulphur has been liberated, and there is also present a considerable amount of black flocculent residue from the lime-sulphur+Black Leaf 40 mixture which has settled on the black-lead deposit. Between these residues there is a thin line of some thin crystalline substance which Professor Tartar suggests may be arsenate of lime.
(7.) Lime-sulphur ..... 17.5 cc. H_2O .....482.0 cc. Zinc-arsenite (Sherwin Williams) ..... 0.6 gms.	May 29th. Combined above materials to get data on results and to note any decompositions of materials. Colour of solution quite similar to that of lime-sulphur of an equal strength with straight water. Slightly cloudy or muddy. The residue was a light grey, being quite a little lighter than that of the neutral arsenate of lead. June 1st. Solution colour of dilute lime-sulphur. A very small amount of free sulphur shows on top of the residue (only a trace).
(8.) Black Leaf 40, 1-1,000..500.0 cc. Zinc-arsenite (Sherwin Williams) ..... 0.6 gms.	May 29th. Combined the above materials to get data on results and to note any decomposition of materials used. The colour of the arsenite of zinc was covered with a pink colouring substance. After standing several hours there seemed to be decomposition of either the Black Leaf 40 or the zinc-arsenite. The latter lost most of its pink colour and appeared dirty white. This zinc-arsenite is more finely divided than that of the California Spray Co. June 1st. Liquid almost white with a slight tinge of black. No change. Apparently no decomposition.
(9.) Lime-sulphur ..... 17.5 cc. Black Leaf 40, 1-1,000..482.5 cc. Zinc-arsenite (Sherwin Williams) ..... 0.6 gms.	May 29th. Combined the above materials to get data on combinations and to note any decomposition of materials which might take place. The solution was black, but appeared no different from the solution of lime-sulphur and Black Leaf 40. The zinc-arsenite had of course settled and, being more or less mixed with the residue formed by the Black Leaf 40, appeared slightly different from the zinc-arsenite lime-sulphur combination. The zinc-arsenite does not seem to be affected by either the lime-sulphur or Black Leaf 40 to any great extent. June 1st. Solution colour of dilute lime-sulphur. Arsenite of zinc a grey colour, showing dark grey at upper surface when solution and residue of Black Leaf 40 come in contact. Black Leaf residue black and flocculent. A small amount of free sulphur present.
(10.) Lime-sulphur ..... 17.5 cc. Black Leaf 40, 1-1,000..482.5 cc.	May 29th. The above materials were combined to get data on the result and to note any decomposition which might take place. When first combined the liquid turns a very dark

	green, and one can hardly see the reason. A close examination will show that there are present such finely divided particles of some green material as to fill the liquid and give the dark appearance. Later these form into larger flocculent masses and settle to the bottom. The liquid is then a dark green. The colour is given by many particles of suspended unknown material. June 1st. Many very minute crystals of sulphur have collected on the side of the bottle. The black precipitate from the Black Leaf 40 still present and settled.
(11.) Lime-sulphur ..... 17.5 cc. Soap-water at the rate of 1 lb. soap to 100 gallons of water ....482.5 cc.	May 29th. Combined these materials to get data on results and to note any decomposition that might take place. The resultant solution was similar to that of dilute lime-sulphur of an equal strength. However, the soap immediately coagulated and formed a flocculent mass which settled to the bottom of the flask. This shows that soap-water and lime-sulphur cannot be combined for spraying purposes. June 1st. Same as above.

Applications made June 16th, 1913.

Ex. No.
(1.) Arsenate of lead (acid) .....8 lb. to 100 gallons water.
(2.) Arsenate of lead (acid) .....4 lb. to 100 gallons water.
(3.) Arsenate of lead (acid) .....2 lb. to 100 gallons water.
(4.) Arsenate of lead (non-acid) ..8 lb. to 100 gallons water.
(5.) Arsenate of lead (non-acid) ..4 lb. to 100 gallons water.
(6.) Arsenate of lead (non-acid) ..2 lb. to 100 gallons water.
(7.) Arsenite of zinc .....8 lb. to 100 gallons water.
(8.) Arsenite of zinc .....4 lb. to 100 gallons water.
(9.) Arsenite of zinc .....2 lb. to 100 gallons water.
(10.) Arsenate of lead (acid) .....8 lb. to 100 gallons lime-sulphur 1-30.
(11.) Arsenate of lead (acid) .....4 lb. to 100 gallons lime-sulphur 1-30.
(12.) Arsenate of lead (acid) .....2 lb. to 100 gallons lime-sulphur 1-30.
(13.) Arsenate of lead (non-acid) ..8 lb. to 100 gallons lime-sulphur 1-30.
(14.) Arsenate of lead (non-acid) ..4 lb. to 100 gallons lime-sulphur 1-30.
(15.) Arsenate of lead (non-acid) ..2 lb. to 100 gallons lime-sulphur 1-30.
(16.) Arsenite of zinc .....8 lb. to 100 gallons lime-sulphur 1-30.
(17.) Arsenite of zinc .....4 lb. to 100 gallons lime-sulphur 1-30.
(18.) Arsenite of zinc .....2 lb. to 100 gallons lime-sulphur 1-30.
(19.) Water without chemicals.
(20.) Lime-sulphur 30.5° Be. 1-30.

These trees had not been previously sprayed, and the leaves were more or less affected with scab. The orchard had only been cultivated once, and therefore was in prime shape to give results in an experiment of this kind.

The two days following the application were more or less cloudy, and the week following varied from rain to sunshine, mostly rain.

Summary of Results.

Lime-sulphur + arsenite of zinc, lime-sulphur + arsenate of lead (acid), and lime-sulphur + arsenate of lead (non-acid) in all strengths caused serious burning. If anything, the non-acid injury was slightly the worst.

Lime-sulphur caused considerable injury, but not one-half as much as in the combination sprays.

Arsenite of zinc alone and in all strengths caused some injury. The injury was different, however, from that of the combination and lime-sulphur sprayed trees.

With the combination sprays the entire leaf was destroyed, or else the injury covered a distinct portion, all parts of which were discoloured. Scab-spots on the leaves appeared black, ordinary leaf-tissue brown.

With the arsenite of zinc only the scab-spots were injured. In a few cases entire leaves were blackened or browned. The majority of the injured leaves were spotted with injury. Each one of these spots was determined to be the seat of germination of a scab-spore. The leaf-tissue between and surrounding these spots did not appear to be injured.

Arsenate of lead (acid) and arsenate of lead (non-acid) did not cause injury in any case.

The tree sprayed with water did not show injury. The injury did not begin to show up badly for about five days, when suddenly, overnight, it appeared at its worst.

As soon as the injury on trees sprayed with arsenate of lead (non-acid) + lime-sulphur 1-30 became apparent, checks were made on different trees of the same block. The check sprays were the same as on the trees 10, 12, 13, 15, 16, 18. The utmost care was used in these applications, and as the same injury occurred a second time, we must conclude that, even with the purest of chemicals, lime-sulphur + arsenate of lead is not a stable spray under North-west conditions.

The controlling factors are yet to be determined. Two other experiments for the control of the codling-moth have not yet been finished. But in one of these lime-sulphur + arsenates of lead, acid and non-acid, and arsenite of zinc did not cause more than slight injury at the first application. The second application on June 30th caused serious injury. Therefore we may say that the above combination sprays are safe for the calyx spray, but are unsafe at the time of the second codling-moth spray.*

RECENT INSECTICIDE INVESTIGATIONS.

(1.) To find the value of lime-sulphur as a stomach-poison.
(2.) To find the value of arsenate of lead (acid) as a stomach-poison.
(3.) To find the value of arsenate of lead (non-acid) as a stomach-poison.
(4.) To find the value of arsenite of zinc as a stomach-poison.
(5.) To find the value of arsenate of lead (acid) + lime-sulphur as a stomach-poison.
(6.) To find the value of arsenate of lead (non-acid) + lime-sulphur as a stomach-poison.
(7.) To find the value of arsenate of lead as a stomach-poison.

The chemicals used were secured from the same source as those used in the spray-injury experiments.

Larvæ of the tent-caterpillars *Malacasoma erosa* and *Malacasoma pluvialis* were used in these experiments, and were placed on sprayed twigs in the open part of the insectary. Newspapers were placed under the twigs to catch the dead larvæ and every experiment kept separate from the rest.

Summary of Results.

In these experiments arsenite of zinc was a quicker-acting poison than arsenate of lead, acid or non-acid, and remained in suspension much better. Acid arsenate of lead was a quicker-acting poison than the non-acid and remained in suspension better.

Non-acid arsenate of lead was slow in its action, but was satisfactory in that death finally occurs.

Lime-sulphur in our experiments has not proven to be much value as a stomach-poison.

Lime-sulphur with arsenicals seems to retard to a more or less extent the action of the poison, and it is possible for larvæ to feed on foliage sprayed with weak

* Arsenite of zinc is apparently not entirely satisfactory under all conditions, and should not be used until after more experimental work has been done.

strengths of lime-sulphur + arsenate of lead, and to recover if transferred to fresh foliage within a few days.

Very young caterpillars placed on twigs freshly sprayed with lime-sulphur 1-30 died within two or three days, but, as they did not feed, death must have resulted from the gases given off.

Very young caterpillars placed on twigs that had been sprayed with lime-sulphur 1-30 and allowed to stand refused to eat, and finally died from starvation.

Half-grown larvæ placed on twigs sprayed with lime-sulphur did not feed like larvæ on unsprayed twigs, but did eat to some extent. After two weeks on lime-sulphur sprayed twigs they were transferred to fresh-sprayed leaves, and finally matured, pupated, and emerged in the adult stage.

Lime-sulphur probably acts as a repellent to biting-insects in the same way that Bordeaux does against the potato flea-beetles. Lime sprinkled or sprayed on the foliage in the same proportions as found in a certain amount of lime-sulphur had no effect.

Mr. E. W. White: I have been delighted to listen to the address of Mr. Wilson. I am sure we will all feel the benefit of his remarks. With our conditions here in British Columbia, contrary to the Oregon conditions, we probably do not under ordinary conditions need to apply more than two sprays annually—the first as the buds show green with lime-sulphur and Black Leaf 40 for aphis, and the second as the blossoms fall for scab and leaf-eating insects.

Mr. Tom Wilson: Professor Wilson claims that aphis-eggs are not killed by the use of winter applications of lime-sulphur. I may say that I believe this to be quite true; I have failed to do so myself. By the addition of caustic soda the necessary effect will be produced. For the woolly aphis I have seen the use of lead paint advocated.

Mr. Lyne: There is one item that occurs to me, and that is the burning effect of sprays. When applying the usual formulæ, if we find the foliage suffering, I find that the addition of lime will control the burning effect of lime-sulphur.

Mr. Cunningham: By adding 6 lb. of lime to lime-sulphur 1-15 no damage results on fruit or foliage. We can also apply a lime spray to control the burning effect of lime-sulphur.

Professor Wilson: All these points bear out our recommendations. We find that lime-sulphur 1-10 can be applied without any injury, but, on the other hand, sometimes an application of 1-40 will result in injury. Consequently no recommendation can be stable.

Mr. L. L. Palmer: I notice in your paper that you have been carrying on your experiments with the use of pure arsenicals. How can we as fruit-growers obtain them? What firms sell them?

Professor Wilson: All our experiments in the past were based on commercial sprays, and we find they vary. We believed that experiments previously carried on by other experimental stations were unreliable, as they never really knew with what they were working. In our work, then, we believed it best to have a reliable basis to work on, and our chemists at the station did this for us. I may say there are two pure arsenates of lead on the market, but I am not at liberty to inform you of the names of the satisfactory firms. The great variations that have taken place in arsenical experiments in the past probably account for the variations in the results. In our work, however, we carried on duplicate experiments with the ordinary commercial sprays. There has been, I fancy, a great improvement in the arsenates of lead during the past few years.

Mr. Taylor: Sherwin Williams arsenate of lead had no effect on cherry-slugs at the rate of 1-40, but 1-20 killed the insects.

Professor Wilson: Pyrethrum at the rate of 1-50 is a most satisfactory spray for cherry-slugs.

A member: Which would you advise us to use, the powdered or paste form of arsenate of lead?

Professor Wilson: It is only a question of time that powdered arsenates will be used altogether.

The Chairman: This has been a very excellent discussion. Forasmuch as the next paper by Mr. Winslow has a bearing on the present discussion, I take pleasure in asking Mr. Winslow, Provincial Horticulturist, to present his paper.

THE ECONOMIC SIDE OF PEST-CONTROL.

BY R. M. WINSLOW, PROVINCIAL HORTICULTURIST, VICTORIA, B.C.

I propose to deal with pest-control on fruit-trees and with the economic side of that question, largely in its relation to the question of costs of production. The cost of controlling insects and diseases on fruit-trees is a part of the larger one of total cost. Our present cost of fruit-production, I am safe in saying, is out of proportion not only to the market prices being received for the product, but is further greater than the production costs of our competitors in those markets. It is true that our fruit has a certain percentage from the Customs tariff, and is, in addition, protected in some cases even more heavily than by the tariff, by more advantageous freight and express rates than our competitors enjoy. It is my own conclusion, however, that the advantage given us by lower freight rates and the Customs tariff does not nearly equal the higher cost of production. If, therefore, our competitors were receiving remunerative prices for their product, our prices, though relatively higher, would be actually less remunerative because of our much higher costs. For instance, skilled orchard labour costs us approximately 25 per cent. more than it does in Oregon and Washington. Most of the materials, such as land, nursery stock, spraying materials, tillage, tools and implements, fruit-packages, paper, nails, packing-house equipment, etc., cost us approximately 20 to 40 per cent. more than our competitors. The fruit-grower's cost of living itself is, perhaps, even higher proportionately, while money both on mortgages and on personal loans costs from 10 to 25 per cent. more. The effect of all these differences is to raise the average cost of apple-production, for instance, in bearing orchards in the interior of British Columbia to about 75 cents a box, as against 50 cents for our competitors; in many cases the difference is very much greater.

The big problem of successful fruit-culture is strictly an economic one. We must be able to sell our fruit at a return that represents at least a margin of profit to the producer, and every possible assistance should be given him to that end. Action has been taken to provide a marketing organization which, while it may not be expected to reduce the cost of marketing, is expected to enhance to some degree the selling-price of the fruit, so providing a larger net return to the grower. The cost of actual production is beginning to give many fruit-growers much concern, and many of them are working to reduce their costs as much as they justifiably can.

As Secretary of the British Columbia Fruit-growers' Association and as Provincial Horticulturist, I have had special opportunities to study the costs of fruit-production, and I am aware that much remains to be accomplished in making savings in every operation in the orchard. Our growers are just beginning to study the economics of their work. Many of them started in fruit-growing with the assumption that profits were so great as to make little economies in production unnecessary. It is an economic law that one part of any general business in the world will stand inordinately high costs, and fruit-growing in British Columbia is not likely to prove any exception. The history of fruit-growing in California and in Western Oregon, the first two fruit sections of the Pacific Coast, amply illustrates this.

Among other things, then, the cost of pest-control is a consideration. You may remember that in the literature issued by Government and by those with land for sale it has been said that pests are at a minimum in the Dry Belt, in which the greater part of our orchards are located; the absence of codling-moth, San Jose scale, and apple-scab, the three most injurious orchard pests, as cited, was undoubtedly correct, and by this intending fruit-growers were led to conclude that injuries

from pests would be small and the cost of pest-control correspondingly so. As a matter of fact, I find that pest-control is costing us a great deal.

It has been a matter of considerable difficulty to get anything definite on what our efforts at pest-control are really costing us, and I must ask you to take my figures only as general estimates, which I have made, however, to the best of my ability.

For the Province, expenditures in 1913 are estimated as follows:—

Materials	$21,170
Application	20,000
25 per cent. of equipment costs	12,500
Total	$53,670

Sixty per cent. of this, which is for the Interior, equals $32,202.

The total value of the fruit-crops of the Interior in 1912, about 1,000 cars at an average of $500 apiece, both of which I think sufficiently high, was $500,000, and the cost of pest-control was therefore approximately 6.4 of the total value packed. From this total there is about $250,000, packing and selling charges, to be deducted. The growers thus received $250,000 for their product, and pest-control, other than fire-blight, costing them $32,202, took 12.8 per cent. of their returns; this was too much. We may easily understand, then, the great drop in the use of lime-sulphur, the principal item, this year to about 58 per cent. of the 1912 consumption.

There seems considerable evidence that growers feel less confidence in the lime-sulphur spray, finding that it does not act as a tonic to the trees, and that it does not destroy aphis-eggs. Spraying each year with lime-sulphur is evidently declining in popularity. Inspector Darlington writes me that in Wenatchee, where San Jose scale has to be controlled, about 50 per cent. of the orchards get lime-sulphur every year, others once in two, and others once in three years. Non-bearing orchards, he states, are sprayed even less. The tendency there seems to be to restrict spraying almost altogether to bearing trees, neither codling-moth nor San Jose scale being of much consequence until trees begin to fruit. In that district, which much resembles the Okanagan, the spraying is confined almost altogether to bearing trees. For this reason, I consider it proper to charge the great part of the cost of spraying to the fruit produced.

I might note that, coincident with the decrease of 41.7 per cent. in the amount of lime-sulphur used in British Columbia in 1913 from that used in 1912, there is an increase of 24 per cent. in the sales of Black Leaf 40, indicating that growers consider aphis the principal pest, and find control during the growing season most satisfactory.

It is possible that more lime-sulphur has been used than was required for most economical pest-control. Wenatchee used one barrel to 25 acres; British Columbia used one barrel to 20 acres, and they have San Jose scale to control, which we have not. A saving, then, might be effected by more judicious use. Spraying at a loss occurs too commonly, and could be avoided if fruit-growers could be induced to study their trees and their needs, and to reason for themselves on how to care for them economically.

Fruit-growers from time to time raise the question of home manufacture of lime-sulphur. I reported on the subject to several interested parties some time since, one of whom has since taken it up successfully. The report is very short and is as follows:—

"REPORT ON COST OF MANUFACTURING LIME-SULPHUR AT OKANAGAN POINTS.

"*Present Cost when produced on Coast.*—The cost, f.o.b. Victoria, is $9 per 40-gallon barrel, which weighs 625 lb. approximately. The freight rate in car-load lots to Vernon is 38 per cent. per 100 lb. The freight to Kelowna and Summerland is slightly greater. Freight charges to Vernon are, therefore, about $2.44 per barrel, making a total cost of, f.o.b. Vernon, $11.44 per barrel, wholesale rates in car-load lots for cash or short terms.

"*To manufacture in Okanagan.*—On a small scale manufacturing in single-barrel lots of concentrated spray, the materials required per barrel are as follows: 112 lb. sulphur, 56 lb. lime. The approximate price of sulphur at Victoria is $28.50 per ton. The freight rate to Vernon on sulphur, car-load lots, in bags, is 67 cents per 100 lb., while the rate on lime in barrels is 33 cents per 100 lb. There is a slight increase to Kelowna, Summerland, and Penticton. The cost of 112 lb. sulphur is $1.60, freight is 80 cents, total $2.40; 56 lb. of lime costs approximately 32 cents and the freight costs 16 cents, a total of 48 cents, f.o.b. Vernon. The laid-down cost of materials is, therefore, $2.88.

"To make up a barrel of spray requires boiling for one hour. Preparation might be estimated at another hour, and there must be a barrel to put the material in. Labour will cost probably 65 cents; a barrel will cost about $1.25; fuel will cost say 30 cents; total cost, $2.20. Paying car-load freight rates on materials, total cost will apparently be around $5.08 per barrel.

"This will not, however, be quite as strong as the commercial product, which tests 32½° Beaume, and the value depends in direct ratio to the Beaume test. Usually it should test about 20° if made under proper conditions.

"If lime and sulphur were brought up to the Okanagan in less than car-load lots, the total cost would be increased to about approximately $7 per barrel, the L.C.L. rate on sulphur $1.24, and on lime 74 cents.

"There would be, in addition, the cost of a hydrometer—$1—and the first cost of the boiling plant, which on a one-barrel scale need not be over $12, and might be kept as low as $3 or $4.

"The local prices of lime and sulphur would probably put the manufacturing of small lots out of the question. There is, in addition, the need for experience and skill in manufacture and in using the Beaume test. The variation in strength of the home-made is an objection."

I learn from Captain Brush, manager of the K.L.O., that he effects a considerable saving by making lime-sulphur on the ranch.

It would seem that, given proper conditions, several dollars per barrel might be saved. On the small scale, especially with inexperience, the saving, however, would be more apparent than real. The O.A.C. bulletin on "Making Commercial Lime-sulphur" is very good and may be followed to advantage. A good report on a successful plant of fairly large capacity is given by Professor Cole in the Washington State Horticultural Society's Report of 1912.

The cost of spraying machinery here is greater than elsewhere, because of a duty of 25 per cent. and long distance from the Eastern manufacturers and consequent high freight charges. We have looked into the question, but fail to find any hope of materially reducing the cost to the purchaser in either tariff or freights. The retailers' margin for handling is small, especially in Vernon, and there is little profit in it for them.

The British Columbia Fruit-growers' Association secures wholesale rates on the principal spraying materials for its members for cash, and the saving effected, by Coast growers principally, amounts to a very considerable sum. They buy about $3,000 annually through the Association, and save about $700 by so doing. This price-list has also resulted in retailers generally quoting these materials at small margins, and I do not look for much reduction in cost there.

SUMMARY.

(1.) Our total cost of production is too high.

(2.) The cost of pest-control seems excessive considering our comparative freedom from pests.

(3.) The high cost of pest-control is due, partly, to high cost of machinery, materials, and labour, but there seems little chance of reducing these costs. None of these are providing excessive profits to makers and dealers under present economic conditions.

(4.) The high cost is partly due to sprays applied as preventives against dangers, minor or fancied, and to the general use of lime-sulphur as a tonic and aphiscide.

(5.) Costs will be most easily reduced by more intelligent study of pest-control, leading to greater efficiency of sprays applied, and to omission of control measures not justified by the net results.

(6.) There may be a saving, under favourable circumstances, by making concentrated lime-sulphur at home, and possibly a nicotine spray could be made to advantage from tobacco-waste in the Kelowna district.

Mr. Cunningham: Would you start economy with spraying?

Mr. Winslow: I can't talk economy in packing and the other branches of fruit-production to the Entomological Society.

Mr. Cunningham: Why not? The growers are falling down on spraying. Did not the low prices that prevailed last year raise the percentage of the cost of spraying? When I was in Wenatchee the one point that impressed me the most was the fact that every grower who had six acres of orchard owned a sprayer.

Professor Wilson: Some of our growers in Oregon are spraying too little, some just right, and some are ruining themselves with spraying.

Mr. Cunningham: I do not know one man in this Province who is using too much spray. I recollect an instance where a man lost his entire crop of McIntosh Reds while the majority of the fruit could have been saved by the use of a spray. What was the 25 or 50 cent cost of spraying in comparison to the value of the apples?

Professor Wilson: Let it be understood clearly that I am not arguing against spraying—much the reverse. I can instance a case of one grower who sprayed four times for apple-scab and you never saw a worse proposition after it all. He did not get the spray on at the right time; he was too late with each application. The amount of spray used has no bearing on the results; it must be put on right.

Mr. Taylor (Kelowna): In my opinion, the use of home-boiled mixtures for scab are superior to the commercial brands. It cost us about 10½ cents to spray a tree yielding $6 worth of fruit. I believe the average grower overestimates the cost of production.

A member: Do not these home-boiled mixtures crystallize before use?

Mr. Taylor: They had better be put on fresh and warm.

Professor Wilson: In regard to crystallization of home-made products, we find that this does not affect the spray in any way. The crystals can be dissolved out in cold water and then used.

Mr. Winslow: If we can control our pests for half the money, will not the other half be saved?

Mr. Cunningham: I do not think the possibility has been shown.

Mr. Treherne: I usually prefer to figure out in a general way the average cost of production of an infected crop and the average yield of that crop to the ordinary grower, and then after allowing a fair interest as returns, about 8 per cent., the difference gives me an approximate idea as to how much may be spent to apply a remedy. This method is not safe, however, if there is danger of losing the tree on which the crop is being grown, and this brings up the question of tree, bush, or annual crops. The personal equation is another important point, for we find a great variation in the business abilities of individuals, and each one can only apply that amount of remedy suited to his pocket, to obtain the best results, economically and practically. I would suggest, however, that the discussion be confined to the point where we can advise the grower what sprays to use on his crops one year with another, or, in other words, what annual sprays are necessary.

Mr. Brittain: There are difficulties in the way of doing this, as conditions change so materially from year to year with different localities. A Vernon grower could not be expected to spray for a pest in Penticton. It is a local problem. Last

year we had an outbreak of cutworms; this year there are very few. It is usually conceded, however, that a spring and fall spraying are necessaries for our condition.

Mr. Cunningham: Can we raise first-class marketable fruit without spraying? If so, where? I don't know. If we are going to compete on the markets, we have to get busy and raise first-class fruit, and this can only be done by spraying. I consider it would be a most unfortunate thing if it gets abroad that the growers are spraying too much. Some men near Vernon have not sprayed for two years. How are they getting along? Are they to remain growing unmarketable fruit? No; get them the machinery and teach them how to spray.

Mr. Taylor: I rather criticize Mr. Winslow if he claims we do not need to spray non-bearing trees.

Mr. Winslow: It is not a question of spraying *versus* non-spraying. It would be most unfortunate if the idea got abroad that I am advocating a cessation of spray application. What I do claim is that a lot of spraying has been misdirected and with consequent discouragement, and how best to find the economic basis.

Mr. Brittain: I think the difference of opinion has arisen from the different view-points taken. I think we can all now gauge the situation.

Mr. Winslow: Lime-sulphur may be made with economy in the valley.

Mr. Taylor: It isn't every one who can make lime-sulphur. The great difficulty is experienced in the resulting varying strength, a variation of 19 to 30 degrees. Another difficulty is the question of the employment of a licensed engineer for small plants.

Professor Wilson: At Corvallis we can make lime-sulphur for $3.75, the retail price being $8.10. It is thus useless paying freight on water.

The Chairman: I think perhaps we had better terminate this excellent discussion, as time is getting on. I am afraid we had better proceed. I will now ask our Secretary, Mr. Treherne, to present his paper.

METHODS OF TAKING INSECT RECORDS IN THE FIELD.

BY R. C. TREHERNE.

In preparing this paper, I had in mind the requirements of the field inspectors working in the various orchards, farms, and nurseries in the Province, with the intention of presenting to them certain ideas in estimating the approximate prevalence of an insect pest and its corresponding injuriousness, so that we may be able to obtain a definite and co-ordinated idea on the nature of our local insect pests one year with another.

In order to determine the present rate of an infestation by any insect pest or fungous disease for comparison with an infestation in past or future seasons or periods, or in order to determine the rate at which an infestation increases in different territories with relation, as well, to dates of migration, emergence, or injuriousness, it is desirable that a definite system of recording the prevalence of an insect pest, one year with another, be employed.

I do not claim originality, altogether, for my suggestions that follow, for, after all, the problems of simple arithmetic are the only ones involved, neither do I wish to force those who are working in the field as inspectors to adopt the systems I propose, but personally I prefer to work with a system when in the field, and the following which I am putting forward as suggestions have been useful.

TO DETERMINE PERCENTAGE OF INFESTATION; INJURY OBSERVED.

Select five typical locations in the field to be examined. At each of these five locations select a typical row, tree, or plant to be inspected. Emphasis should be laid upon the word "typical," no partiality or impartiality being shown in the selection. When this is done, count fifty plants, buds, fruit, or leaves, as desired, and examine carefully for injury. Then *the total number of injurious marks divided by the total number of objects examined, multiplied by 100, gives the percentage of*

infestation. If it is possible to examine the objects without injuring them in any way, and it is wished to follow the observations by others during the same season to obtain the *progress of infestation*, stakes or markers should be used, so that the same area or ground is covered each time. The number of insect injuries that can be examined in this way are necessarily limited, but we find examples in the stinging of fruits, etc., by such insects as the curculio, capsids, sawflies, and so on.

Progress of infestation can, however, be obtained, when the objects are destroyed, by frequent examination within a certain area. Results then can only be gauged by charting the notes obtained and general survey taken over a greater or lesser period of time.

Let us take the instance of a field of turnips affected with the root-maggots (*Pegomyia (Phorbia) brassicæ*). If before thinning we pulled up fifty young plants in each of five locations in the field and examined for maggots and their injury to the roots, and noted it in the following manner, viz.:—

North	Out of	50	plants,	0	were infested.
South	„	50	„	7	„
Centre	„	50	„	8	„
East	„	50	„	10	„
West	„	50	„	9	„
Total	Out of	250	plants,	34	were infested.

Then 13.6 represents the percentage of infestation.

Determinations of this nature can be made the basis of many series of observations and experiments, and the details can be arranged to suit the requirements of the case at the discretion of the inspector.

To estimate the egg, larval, or adult abundance to an acre when the insect or its stages are observed, we first must know the lineal feet of row per acre. The following table, therefore, is compiled, derived by division of the number of square feet per acre—viz., 43,560—by the width of the row:—

Rows in Feet apart.	Running Feet per Acre.
2½	17,424
3	14,520
3½	12,445
4	10,890
4½	9,680
5	8,712
5½	7,920
6	7,260
6½	6,701
7	6,222
7½	5,808
8	5,445
9	4,840
10	4,356
11	3,960
12	3,630
15	2,904
18	2,420
20	2,178
30	1,452
40	1,089

To put this table into application, let us suppose we wish to determine the egg-abundance of the cabbage-maggot (*Pegomyia (Phorbia) brassicæ*) in a field of turnips, the adult abundance of the strawberry-root weevil (*Otiorhynchus ovatus*), the adults

of which are found on the ground surface in rows of strawberries, or any such insect affecting small fruits or vegetables in cultivated field or garden rows; first stake off 1 foot of row, count the insects or insect forms as desired, and estimate the average per 100 feet of row; then divide the running feet of row per acre, coinciding with the distance of rows apart, by 100, and then with the figure thus obtained (as per table) multiply by the number of insects estimated on the average of 100 feet of row. For example:—

In 1 foot of row	4	insects taken.
„ 1 „	2	„
„ 1 „	0	„
„ 1 „	5	„
„ 1 „	4	„
Thus in 5 feet of row	15	insects were taken.

The average per 100 feet of row is 300. Let rows be 4 feet apart. Thus 300 x 108.90 gives an estimate of insect-abundance of 32,670 to the acre.

Supposing, once more, the above estimate referred definitely to the egg-notes of the cabbage-maggot, by reference to the habits of the insect we know that each female is capable of laying on the average fifty eggs; thus by dividing 32,670 by 50 we estimate with reasonable assurance the number of adult female flies at work on the acre at any specific time.

Of course, in a case like the above the flies may be at work laying eggs at the same time as our records were being taken, and the same might occur with any insect having a continuous generation, consequently our results taken two or three days later might be very different to the first ones taken; thus it is advisable, in order to obtain uniformity, moderate exactness with a minimum of error, to examine the same plants several days in succession or several times during a certain period.

In the case of making estimates on nursery-stock rows, gooseberries, currants, raspberries, or such-like bush-fruits, 1 foot of row is too small an area to obtain results; consequently 100 feet of row or fractions of the same are taken. For example:—

In 100 feet of row	10	insects	are observed.
„ 100 „	2	„	„
„ 100 „	0	„	„
„ 100 „	14	„	„
„ 100 „	4	„	„
Total 500 feet of row and	30	insects	observed.

Average per 100 feet is 6 insects. Let rows be 4½ feet apart. Thus 6 x 96.80 equals 580.8 insects to the acre.

In the case of young orchard trees set on the square-planting plan, corn-hills, tomato-plants, or any plants grown on the square equidistant hill system, the following computation on the number of square feet of row per acre will be found most useful as a basis for figuring:—

Distance in Feet.	No. of Plants per Acre.
1	43,560
1½	19,360
2	10,890
2½	6,969
3	4,840
3½	3,556
4	2,722
5	1,742
6	1,210

Distance in Feet.	No. of Plants per Acre.
7	889
8	680
9	537
10	435
12	302
15	193
18	134
20	108
24	75
25	69
28	55
30	48
40	27

To obtain records to the acre from this table, the number of insects found infesting a tree or a hill would be multiplied by the number of plants to fill out the acre, coinciding with the width of the rows.

To the working field inspector some sort of system as mentioned would be of value. The tables might be typewritten and pasted in the front of the pocket note-book for ready reference.

The type of note-book of most use, to my mind, is a fling-cover loose-leaf kind, about 7 x 4½ inches to the cover, with pages about 6 x 4½ inches. Each page may be already printed in form somewhat as follows:—

Orchard of .....
Address .....
Name of insect present .....
Prevalence .....
Degree of injury .....
Condition of crop .....
Remarks .....
Inspected by .....
Date .....

Each form is preferably reserved for one insect, and each one, when filled out at the end of the week, is filed away for future reference and report.

However, all these details are merely incidental and subject to individual preference; the main principles, however, are accuracy of report based on a continuous and satisfactory system.

I wish, in conclusion, to say that these various methods of obtaining insect records in the field are far from scientific. The facts obtained are too general in nature and the possibility of error is too great. However, to the working field inspector these may prove of use in his work.

The Chairman: I am sure the schemes suggested will be of use in a general way. I will now ask Mr. Cunningham to give his paper.

THE WORK OF THE INSPECTOR OF FRUIT PESTS.

By Thos. Cunningham, Inspector of Fruit Pests.

I have been requested to prepare a paper for this meeting on the work of the Government Entomologist. The title was chosen without my knowledge, and I have therefore taking the liberty of making a slight change which I believe will more fully describe the duties of the Inspector of Fruit Pests. This title is comprehensive and unique; it was chosen in the early pioneer days when the few fruit-growers then in the Province were feeling their way cautiously toward the development of an industry which has since attained such proportions, and now plays such an important part in the settlement and commerce of this country.

Some twenty-five years ago the fruit-growers of British Columbia formed themselves into a society known as the "Provincial Fruit-growers' Association," the object being mutual assistance in selection of lands best adapted for horticulture, and the varieties of fruit that gave promise of success in a new and practically undeveloped and untried country. The Government of the day, from the very first, took a kindly interest in our affairs, assured us of their readiness to assist us financially, and by such legislation as would receive the approval of the Association. As earnest of the Government's good intentions the sum of $1,000 was placed on the estimates for the use of the Association. I may state that in those days this was considered a very liberal grant. But the financial assistance, though very helpful, was not by any means as valuable and important as the protection which the Government subsequently, and at the request of the Association, placed in the Statutes of British Columbia.

Taking advantage of the assurances given, the Association drew up a Bill entitled the "Horticultural Board Act," by which a Board of Horticulture was created, and the Province divided into three horticultural districts. The members of the Board were chosen by the Government, the term of service being four years; they were eligible for reappointment at the will of the Government.

The "Horticultural Board Act" empowered the Board to make such regulations for the promotion and protection of the fruit industry as the Board thought necessary and expedient, subject, however, to review by the Attorney-General. After having the approval of that officer, the regulation, or regulations, were published in the Government Gazette, after which they had all the force of a statute law. This valuable provision is the key to the success of British Columbia in protecting the Province from any of the destructive pests which afflict the horticulturist in other countries. It is, I believe, greatly to the credit of all the Governments that have been in power during all these years, and also to the prudence of the Board of Horticulture, that not one regulation or decision of the Board on any matter affecting the fruit industry has been vetoed or disallowed during the entire history of the Board, nor has the Federal Government refused its consent to the enforcement of our regulations even when such enforcement bordered on interference with trade and commerce.

I trust that I will be pardoned for venturing the opinion that the good fortune which has attended the operations of the Board and its officers is mainly due to firm, just, and impartial administrations of the horticultural regulations. Not once in the history of the Board has it been shown that even-handed justice was not administered alike to small and great. Not once has the Government been compelled to interfere or reverse the decision of the officer having charge of the enforcement of the laws. Considering the cosmopolitan character of the settlers of this Province, such as importers, consignees, and canning companies, and the varying interests involved, this record is something of which all good citizens may well be proud.

Immediately after the Board had agreed on a code of regulations it was found necessary to appoint an executive officer whose duty it is to enforce such regulations, and as his duties involved inspection of all nursery stock, whether imported or home grown, and all imported fruit, it was agreed that the title of Inspector of Fruit Pests would be most appropriate. All destructive insects, fungous and bacteriological diseases may be included in the term "pests," so that the title, though very uncommon, was, perhaps, as consistent and satisfactory as any that could have been chosen.

During the first few years of the operations of the Board there were only three varieties of fruit subject to inspection—viz., apples, pears, and quinces. Not until the appointment of the present incumbent were peaches, apricots, plums, cherries, oranges, lemons, grape-fruit, and pine-apples subject to inspection. As trade with the Orient, Australasia, Sandwich and Fiji Islands began to develop, it was found that we were exposed to the introduction of many destructive pests not commonly distributed in the neighbouring States; this has led up to the inclusion of all vegeta-

tion arriving from those countries being subject to close inspection. The discovery of the larva of the tuber-moth in Californian potatoes, worms in cabbages, carrots, and turnips during the present year has resulted in all those vegetables being made subject to inspection, and are now very carefully inspected.

There are some twenty ports of entry in this Province where fruits, vegetables, and grain may be entered. The Board of Horticulture maintains an officer at each port whose duty it is to inspect all such importations before the goods can be delivered to the owners or consignees. Goods coming from other Provinces of the Dominion and British possessions throughout the world are subject to the same system of inspection as those coming from foreign States and Territories.

It is the duty of the Inspector of Fruit Pests to see that this system of inspection is firmly enforced. Each officer is required to make monthly returns of all inspections, so that the Government is kept informed regarding any threatened danger, and the Board advised of such additions and amendments to the horticultural regulations as may be found necessary to meet new conditions.

All nursery stock, trees, and plants of every description are subject to rigid inspection; all plants and trees carrying visible infection of destructive insects, fungous or bacteriological diseases are promptly condemned, and either cremated or reshipped to the country from whence they were exported. During recent years a very small proportion of condemned stock has been reshipped; nearly all has been cremated. It has been our policy at the inspecting and fumigating station to discourage the return of nursery stock. We believe that the only safe place for infected nursery stock is the furnace.

As a further precaution all nursery stock, including ornamental shrubs and plants, except those grown under glass, are fumigated with hydrocyanic-acid gas, United States formula.

All Indian corn, brown rice, or other grain showing infection are fumigated with carbon-bisulphide. This treatment has been found to be exceedingly effective; all animal life is destroyed without the slightest injury to the grain.

It often happens that hides and pelts in transit from Australia to the United States must be fumigated at Vancouver. We are glad to undertake all such service on behalf of our cousins, who have from the earliest history of the Province of British Columbia rendered willing and most valuable service in the interest of horticulture. I take this opportunity of testifying that not once in my experience of a quarter of a century have I been refused the very best technical information and assistance from our cousins south of the International Boundary, despite the fact that I have often been obliged to inflict severe financial loss on some of their people by the destruction of diseased and infected vegetation. Not in a single instance have any of their experts or officials who are in any way connected with the great fruit industry, or their educational system, suggested that we were too severe in the administration of our defensive system. On the contrary, I have ever received encouragement from their Entomologists and Plant Pathologists to enforce our horticultural regulations with firmness and justice.

I desire publicly to thank the representatives of that great and noble nation who are present with us to-day for the generous assistance and encouragement that they have given, with unstinted measure, during the whole of my experience.

The duties of the Inspector of Fruit Pests are often, indeed they are mostly, unpleasant; but considering the importance of protecting this beautiful and promising young Province, which is teeming with undeveloped wealth, and is being rapidly settled with a superior class of people, unpleasant duties must not be considered.

The regulations of the Board of Horticulture have been devised and promulgated in the interest and for the protection of the fruit-grower, the farmer, the capitalist, the canning companies, the consumer—in fact, for every resident in this Province. It is the duty of the executive officer of the Board to see that these wholesome and necessary regulations are enforced. It is no less the duty of every man who profits

by this valuable system of protection to aid by all lawful means those who are appointed from time to time to enforce the horticultural laws of British Columbia.

The reorganization of this Society is bound to have an important and beneficial effect on the agricultural and horticultural development of this Province. The presence of trained experts here to-day, to give us the benefit of their research and experiments, is a sure guarantee of a great forward and benevolent movement for the good of all concerned.

May our deliberations result in stimulating our people to greater efforts and deeper research in all matters that pertain to insect-life and plant pathology is the earnest desire of the Inspector of Fruit Pests.

THE IMPORTANCE OF ECONOMIC ENTOMOLOGY AS A SUBJECT OF EDUCATION.

BY M. H. RUHMAN, GRAND FORKS, B.C.

In this vast country with its wonderful agricultural and horticultural future the study of economic entomology is of vital importance to the general welfare of the country. The business-man in town is as much concerned as the farmer, fruit-grower, and lumberman; the success of our agricultural communities and forestry-work will always, in a great measure, affect the business of our cities and towns and the general finances of the country.

With the rapid development of the land, the insect pests are not yet very noticeable, except in the more settled districts, but such pests as are native to this country, and such introduced pests as have become established, are slowly but surely spreading and increasing throughout the country, and consequently increasing the already great annual loss of crops, which, in cash value to the individual grower, would be the equivalent of a high rate of interest on his legitimate profits, which, if he only realized the extent of this tax, he would surely try to avoid.

It is stated that 50 per cent. of the insect pests of the United States of America are introduced species. Introduced insect pests are generally the most serious and the more difficult to control, as frequently the parasites of these pests do not exist in the country into which they have been introduced, and as the parasites are by far the best, and in some cases the only means of keeping insect pests in control, it therefore becomes essential that the life-histories of insect pests be studied, both in this country and in the country or countries from which they have been introduced (where they may not be considered serious on account of parasitic control), that the parasites may also be introduced when found necessary.

The very rigid inspection of nursery stock, plants, and fruit enforced in Canada makes it almost impossible for insect pests to be introduced through these channels, but there are minor channels through which insect pests could and probably are being introduced which it would be impossible for the Government to entirely control. I might mention such possibilities as migration from the United States of America, introduction with general effects of immigrants and in material in which merchandise is packed and shipped from foreign countries; these minor channels are a real danger which cannot be entirely avoided. The business-man in town may leave the packing material of imported products lying about, or uses it again for packing things for shipment to home points instead of destroying it; also the farmers and fruit-growers are apt to leave packing material about for some considerable time before destroying it, thereby giving insect-eggs which it may contain an opportunity to hatch and the minute larvæ to get to some food-plant which may be near, or imagos may emerge from pupæ which the packing may contain.

The most destructive pests are generally very small and would, on that account alone, escape notice; even the larger species if seen would not attract attention unless the observer were a live entomologist. In the event of the introduction of a few insect pests in this way they could escape notice for some considerable time, perhaps

until they are actually doing serious damage and have become well established. A small infection, if immediately noticed, can generally be stamped out without much trouble or expense.

The reason that a pest could become well established in this country is, I think, obvious; the general public, particularly the farmers and fruit-growers who are most concerned, do not realize the importance of economic entomology, and consequently take but a passive interest in the great work the Department of Agriculture is doing for them on this subject. It carries on investigations in all branches of agricultural science, and issues its bulletins and circulars when necessary or desirable, giving the growers information and advice on the various problems before them; but it lies with the growers to act upon such information and advice, which they no doubt do in matters which they understand and appreciate, but how many realize the importance of economic entomology to themselves? To appreciate the importance of this subject one must have at least an elementary training in the study of insect economy.

Amongst the later generation of farmers and fruit-growers we find more people with a business training who appreciate the importance of economic principles, and who are anxious to obtain the best possible results for their investments and labours; they make use of the information and advice provided to the best of their ability, but in the case of insect pests most of them have not the elementary knowledge, nor the powers of observation, necessary to make use of the advice to their best advantage.

To be successful in this important branch of his work the farmer and fruit-grower must in the first place take an active interest in insect-life; they must learn to recognize the more common insects that they meet with every day, and learn the metamorphoses of insects generally; they should also develop their powers of observation sufficiently to be able to notice a small insect at rest on a leaf, flower, or fruit. Once a man has acquired a slight knowledge of insect economy, he cannot help but be greatly interested in the subject; once a practical interest is taken by the farmer and fruit-grower, there will be little danger of a serious pest escaping notice for any length of time. They may not recognize the insect, but they would be all the more likely to take notice of it on that account, and have it identified at the earliest opportunity, and there would be very few growers reluctant to spray and use other preventive and remedial measures.

Man has a natural love for nature which he seldom realizes, and which in later years is all too frequently entirely superseded by the all-absorbing hunt for the elusive dollar. It would be thought strange if a child did not love the flowers, birds, and butterflies; it is the natural instinct of a child to be interested in nature; yet very little effort is made to develop the child's natural instincts to a practical purpose. I think an effort should be made to get the children in the schools practically interested, by giving them, say, one hour a week for instruction in botany and economic entomology, not dry scientific matter which would be all Greek to them, but teach them to recognize the common flowers, weeds, and trees. The same with the common insects; explain their metamorphoses to them and their economic importance; teach them to place the insects in their proper order, according to their structural peculiarities; give them a very elementary and popular training in these subjects, and in later years we will have a great number of people in this country with a fair knowledge of plant and insect economics, and also tend to develop systematic and economic entomologists, who are greatly lacking in this country. Induce the older children to form field-naturalist clubs in each district and assist them in every way possible with instruction and advice. This country needs systematic and economic entomologists, and needs them badly; we cannot have too many of them, and they are not made in a day. Let us get busy to attain this end; it will incalculably benefit our great Dominion.

PRESIDENT'S ADDRESS.

(G. O. DAY, F.E.S.)

It gives me great pleasure to be here to-day and to take part in this very successful meeting. It was a happy suggestion, which I think is due to Mr. Brittain, that a summer meeting should be held, and held in Vernon. I think the Society is fortunate in having as Secretary and Assistant Secretary such able, energetic, and enthusiastic men as Mr. Treherne and Mr. Brittain. So long as they are kind enough to act, I feel sure that the Society will have its interest sustained, and the precedent they are setting will be a fine incentive to those who follow after. It appears to me that you have in this neighbourhood more numerous—I will not say more enthusiastic—followers of the study of entomology than the Coast and Vancouver Island, and that Vernon might easily become the headquarters of the Society.

In regard to this question, it occurs to me that in appointing future Presidents and Vice-Presidents it might be advisable to choose one from each district; that is to say, a President from Vernon and a Vice-President from Vancouver, or vice versa. But, of course, that can be discussed at the general meeting in January.

What I particularly want to do this evening, in the few remarks I have to address you, is to make a plea for the study of what is called, for the want of a better description, "Systematic Entomology." When I looked through the programme of the proceedings of this meeting, it seemed to me that the economic side held the field. I was in hopes that some of the papers might include general entomology, but this was not to be. Please do not mistake me and think that I do not appreciate economic entomology. The study is most interesting and valuable, but I wish to urge on all our members the broader view of the whole field of entomology. The collecting, naming, classifying, and making life-histories of any order of insects possess a great charm, which no doubt most of us realize. It is quite right that economic entomology should hold first place. It is a most important study, and its importance is being increasingly recognized as time goes on—principally, I think, because the general public are being enlightened by the bulletins on the subject which have been published by the various scientific bodies, showing the enormous damage collectively done to growing crops and trees, and also by interesting articles on insects given in the popular magazines. Up to quite recent years entomology was looked upon as a merely puerile pursuit. It is a curious fact that anything that is cheap and plentiful is held in light esteem, I might almost say despised, by mankind in general. To them all insects are common and insignificant looking and below the serious notice of grown men and women (except the said insects sting), and the person who dabbles in them and studies their little ways is considered a poor harmless kind of individual of very eccentric tastes. But when "the man in the street" recognizes that there is money in it—that the control of insects means money, and the State considers the matter important enough to employ specialists to obtain information and to pay them for the work—then the subject assumes a different aspect.

This is a great gain in public opinion, and I hope that the increased respect already obtained for the subject will continue to grow, and that the appearance of a person with a butterfly-net in the country will not cause any more amusement than seeing a man with a fishing-rod or a bag of golf-clubs.

Then, again, the importance of the economic side is emphasized by the fact that the Society is subsidized by a grant from the Provincial Government, and the authorities will naturally like to see some practical results from the members of our Society. This is already assured by the useful and informing papers which have been read and which are to be delivered to-morrow. So I may urge upon the members what I may call the natural-science side in contradiction to the ultra-useful side. I must confess to feeling rather out of place among such a number of eminent

economic entomologists; your studies and knowledge are along lines differing from those of the systematist, and you know so much more of your subject than I do. The economic side is all for destroying. To paraphrase a sentence in the Bible, the economics say: "This is an insect, come let us kill it, that the fruits of the earth may be ours."

While systematists are not bound by the law "Thou shalt not kill," and it is true that a great number of insects are killed by collectors, still the object of all lovers of the pursuit is to preserve species from extinction, and the tendency is against killing, for to every one of a sensitive nature the wholesale destruction of life must always be distressing. My object is to advocate some endeavour to make the two sides overlap, by urging the economics to take some interest in the collecting, naming, and recording of insects of whatever order they may feel a preference for; and for the collectors to do a little more work in the life-histories of their respective pet orders. I think the more attention is given to this, the more interesting the study becomes.

There is a wide field of useful work waiting to be done in British Columbia, and our Society has a fine opportunity of doing the work. The Society is a nucleus to which will be attracted all those in the district who take an interest in entomology, and which can gather up and record and preserve the work of its individual members. I look forward to the day when the Society shall possess an establishment of its own where it can have collections of named specimens in all orders and with a library of books of reference for the use of its members. It will be a great gain when students can compare specimens with those in the Society's collections and have a certain degree of certainty as to the correct name of the specimen they are examining. Moreover, it would be an incentive to the members to work to obtain species not represented in the Society's collection. The subject of Lepidoptera has, I think, so far received most attention. But even in this branch only the surface has been skimmed. The commoner species are pretty well known, but assiduous work by a greater number of collectors would, I feel confident, bring to light many species hitherto unrecorded, at all events in British Columbia.

What authoritative voice have we on the British Columbia insects? True, Mr. F. H. Wolly-Dod is making a special study of the Noctuidæ, and Drs. Barnes and McDunnough have published valuable notes on some of the rarer species, but since the lamented death of the Rev. G. W. Taylor I know of no special authority on the Geometridæ. Some little work has been done in the Diptera and quite a fair amount in Coleoptera, but, so far as I am aware, the other orders have been sadly neglected.

There is a good field for the study of Neuroptera, including the dragon-flies, and any one taking up Hymenoptera would find the subject most interesting, with untold opportunities for finding new species. I would strongly recommend to our members the serious study, as systematists, of some branch of this order, either ichneumons, gall insects, ants, wasps, bees, sawflies, or any other subdivision, for Hymenoptera is rather a large order to take as a whole. Unfortunately, there does not appear to be any authoritative list on the order in Canada to work upon as a basis. If you look through the records of the Canadian Entomological Society for the last six or seven years, you will find that meagre attention has been paid to this order. Therefore there is a splendid opportunity for original research.

Moreover, in Hymenoptera specially, the economic entomologist and the systematist would work on common ground, for in this order is found nature's chief control of other insect pests.

The scientific study of the order would add materially to our general knowledge and should make a valuable contribution to our British Columbia list of insects, and, above all, it would forward the amalgamation of the economic and systematic sides for which I am pleading.

SOME PROBLEMS IN APHIS-CONTROL.

BY L. L. PALMER, HORTICULTURIST, COLDSTREAM ESTATE CO.

No one should appreciate the value of the present meetings more than the fruit-growers and farmers of British Columbia. The men actually engaged in the cultural operations of their farms, day after day, need to get away from local conditions. Such a change broadens the scope, and they go back to their work with renewed energy and zeal.

Individually and collectively, the growers of British Columbia are facing a great economic problem. Not a phase of the fruit and gardening industry of our Province, from the different cultural operations to the wide questions of marketing and distribution, that is not being systematically and thoroughly studied, in the endeavour to place our industry on a par with the industrial enterprises of our cities.

This work must not be left to the Government alone. Without the co-operation of the growers themselves the greatest good cannot be accomplished. The final product will measure up to the standards, which as a united body we are aiming to attain, directly in proportion to the manner in which each farmer and producer turns over his finished product to the public.

There is not one single operation in the proper care of orchards that may not influence the quality, the size, and the appearance of the fruit produced. These operations the individual owner or director must control, and upon his knowledge and ability to apply that knowledge depends the success of the industry. He must know his own local conditions, so that he may prune wisely; that he cultivate advantageously; that he may spray timely. The Government cannot study each separate ranch so minutely and practically as the owner; but what the Government can do, and is doing, is to furnish scientific principles and definite knowledge which must be applied to peculiarities of each varying location.

Of all the orchard operations, none tax the ability of the grower more than the prevention and control of the insect pests and diseases to which his special district is subject. This is a question upon which the grower must continually renew his store of knowledge, because great progress is constantly being made as to improved methods of control and as to actual information regarding life-habits of economic insects. Mr. Winslow has given us a grasp of the amount of damage done annually to our fruit-trees by insect pests. As fruit-growers, it is our duty to be sure that we are not, by neglect on our part, adding to and influencing the cost of decreasing such a loss.

Chief among the economic pests of British Columbia are several species of aphides. These sucking-insects are very generally scattered throughout fruit-growing regions, and cause the grower a large amount of trouble. It is not my purpose to give you a detailed description of the life-history and habits of all different species of aphides which may be found in different parts of British Columbia, nor will time allow me to give a discussion of the relative merits of different sprays used in controlling these. Many experimental stations have printed good descriptions and effective methods of spraying, which are gladly furnished upon written application. I want to call your attention to some of the problems the grower faces in combating aphides in the Okanagan, and the relation of other orchard operations to this important factor in the production of "quality fruit."

When a grower's fruit falls below standard, some operation, or series of operations, is at fault, unless the grower is so unfortunate as to be trying to produce under adverse soil or climatic conditions. Did he plough the past spring so as to get the greatest good from soil conditions? Was his orchard subject to seepage? Did his pruning result in forced growth? Did he skip his usual spraying? Many questions will arise, any one of which answered negatively may have been the cause, directly or indirectly, of his poor results.

The point I want to underline here—to exaggerate if necessary—is the fact that every operation performed in the orchard has its influence on the final product; also upon the efficiency of all operations depends the success of spraying, of pruning, of cultivating, and of all other phases of orchard-work. If you neglect one, you lose most of the value of the work expended on all the others for the current year. On an orchard of my own, I thoroughly cultivated, I carefully pruned, I properly thinned, I effectually sprayed for codling-moth; but the result of these operations produced a large per cent. of small gnarly fruit. Each operation cost money—money advisedly spent if the final product had been up to standard. Gentlemen, I neglected to spray for rosy apple-aphis because I thought I could save about $5 an acre by so doing. In the end my product was worth from $50 to $100 an acre less. But that was not my only loss; I had expended from $10 to $15 an acre to thin. Where and when was I to get that back? A conclusion to me was self-evident: A fruit-grower cannot afford to allow any insect pest which directly or indirectly injures the quality of the product turned out to go uncontrolled, or he will not only lose the value of the crop, but also the cost of producing it.

If the cost of production is too high, the grower must reduce it, not by neglect of any single operation, but by making one operation aid another, by more thorough work in fewer operations; in fact, by better balancing of all the factors which make for the production of No. 1 fruit.

In controlling orchard pests, economy is just as essential as in other lines of business. If the orchard is infested with several different insects, endeavour at one operation to destroy as many as possible by using that combination of sprays which scientific research and practical application have proven most effective.

Many orchards in the Okanagan are infested with woolly and green apple-aphis and scale-insects. Thanks to the work of entomologists, we know something of the life-history and habits of these insects, and what class of sprays is effective against them.

The best time for the application of spray material, were we treating these insects separately, would vary, but it is possible by thorough work to kill the one which is doing the most damage, or the two which are of greatest economic importance, and also very effectually check the third. Thus, had I an old orchard infested with these three pests—woolly apple-aphis, green apple-aphis, and oyster-shell scale—under Vernon District conditions I would spray as follows: Previous to the opening of the leaf-buds in early spring, apply with power-sprayer and pressure of at least 175 lb., winter-strength lime-sulphur, dilution 1 part concentrated lime-sulphur to 9 parts water, to which is added 1 part of Black Leaf 40 to every 800 parts of the lime-sulphur solution. This combination should kill all over-winter woolly aphis above ground, as well as oyster-shell scale, when thoroughly brought in contact with insects. Be sure every crevice and crack in the trunk and limbs is drenched with the spray. This will not, however, kill all the green apple-aphis eggs. The addition of Black Leaf 40 seems to be much more effective in killing both the woolly aphis and the scale than the lime-sulphur alone. In the Vernon District the past season, which was a late one, this spray was applicable April 5th to 15th, inclusive.

Should the orchard in question be principally infected with green apple-aphis, as are many of our younger-bearing orchards, an application of spring-strength lime-sulphur, 1 part to 30, to which is added Black Leaf 40, 1 part to 900 parts of diluted lime-sulphur, applied after the leaf-buds have just opened, will kill effectually the greater part of green apple-aphis, which have mostly emerged from eggs but have not yet had time to curl the leaves.

I consider the spring spraying the most important and essential, as the killing of all aphides present in the orchard at that time gives the trees an opportunity to make good, strong growth before reinfestation. The woolly apple-aphis requires special attention in this section. I do not believe growers appreciate the damage caused by it. I cannot but attribute a large amount of the diseased cankers on

the trunks and limbs of trees to these piercing plant-lice. At least, I am sure of the orchards on Coldstream Estate; those which have been infested with woolly aphis have been clearly the most subject to many forms of canker which found foothold through punctures in bark caused by these aphides. It is likely that where continued infestation has taken place the stimulated growth and gall formations caused by woolly apple-aphis will so weaken a tree as to make it more subject to the ills of adverse physiological conditions.

Many growers are attributing their losses of crops, and their troubles with silver-leaf and fruit-pit, to physiological troubles, and yet are neglecting to study ways and means of keeping their orchard conditions balanced, so as to meet any excessive moisture during summer or fall season; to better withstand the inroads of frost in winter; in fact, to hold the trees as nearly to the normal as possible. A tree loaded with woolly aphis is not only injured in the trunk and limbs so that they are not able to perfectly perform their functions, but the roots are often killed to such an extent as to prevent the proper flow of sap. Yet growers wonder why such trees are not producing good crops of high-class fruit every year.

In addition to the early spring spraying for woolly apple-aphis, an application of a 15-per-cent. solution of kerosene emulsion, or Black Leaf 40, 1 part to 900, about the 10th to 15th of September, in Vernon District, will free the tree-tops of these insects previous to the appearance of the winged viviparous females, which probably migrate to another host-plant, beyond control.

There are many spray combinations equally effective in other locations as are the ones I have briefly suggested for this district, and opinions differ widely as to when and how they should be applied. But the orchardist's problem in controlling pests does not stop with the knowledge of the life-history of insects; with the best sprays to use or the right time to apply them; nor is spraying alone the most economically effective means of controlling them.

It is necessary to make every phase of orchard operation tend to help every other, and the grower who successfully does this reduces to a minimum the expense of orchard care. For example, trees infested with woolly apple-aphis are most dangerously infected in the roots and generally in the first foot of soil, within a radius of 3 to 4 feet of the tree. It is very expensive to shovel the dirt away from the crown of the tree for spraying, but sometimes even this would pay. However, I believe you can do better. In the spring or early fall, if moisture conditions are favourable, start single ploughing by throwing a furrow away from tree on each side—a necessary operation every other year. Have a man follow up the plough and with a large digger-hoe, or shovel, expose as much of crown and roots as possible within a 4-foot radius of the tree. This can be done very quickly if you catch moisture conditions just right. Follow this up with a thorough spraying of kerosene emulsion, forcing the spray well into the soil about the crown and base of the tree. You are in this case taking advantage of another orchard operation which makes the spraying more effective.

Another example: The eggs of the green apple-aphis are found extensively towards the end of the previous season's growth. Very frequently those eggs will be deposited on one or two growths only to a tree. If you can arrange your labours so as to prune the trees from one to four years old in late winter or early spring, you can easily see the shining black eggs and clip them off in the regular pruning operation, putting the cuttings in neat piles at one side of the tree, to be easily hauled off and burned. By pruning young trees in the late winter here, you avoid exposing immature wood to our cold winter weather.

In connection with pruning to control aphides, some growers practise cutting off shoots in summer as fast as aphides appear on them. The infection is so scattered that it seldom pays to take out the power-sprayer, and with the exception of very small trees the ordinary hand knapsack sprayer is not effective. It is certainly a complicated problem. If you prune off the infested shoots in early July you cause a forced, soft, bunched growth which never matures and is easily

frozen back in winter. If you take out the power-sprayer the cost is excessive, yet if you wait for the whole orchard to become infected and then take out power-sprayer the leaves become badly curled, making it hard to kill all the aphides, and the growth of the shoots is so bent and crooked that it gives the tree a bad appearance.

Personally, I have often practised cutting off the young shoots as they become infected, helping the expense by removing unnecessary water-sprouts and suckers at same time, but I believe spraying is the only way, under Vernon conditions, where we must do all we can to avoid excessive soft growth.

I now use a knapsack sprayer called the Standard Spray Pump, with which it is possible to spray trees even up to twelve years old, and can be used with bucket, knapsack, or barrel, and works very much like a bicycle-pump. It comes fitted with three nozzles, one of which gives a fine mist spray, with surprisingly strong pressure, so that it can be thrown 10 to 20 feet effectively. I have brought one with me and shall be pleased to demonstrate it to any one at close of meeting.

There are a great many other problems in "aphis-control" which are special to the grower under his particular exposure. In fact, like all operations in the orchard, the really efficient and economic control of pests must be met by the ingenuity and practical knowledge of the individual grower, because he alone knows all the other factors which influence successful fruit-culture.

TWO INJURIOUS INSECTS OF ECONOMIC IMPORTANCE ATTACKING PEACH, APRICOT, AND PLUM TREES.

BY W. H. LYNE.

Mr. Chairman, Ladies and Gentlemen,—In dealing with the subject assigned to me on the programme under the title of "Peach Insects," with your permission I will confine my remarks to discussing two insects of considerable economic importance. These two insects—namely, the peach-twig borer (*Anarsia lineatella*) and the peach-root borer (*Sanninoidea exitiosa*)—do not confine their work of destruction to the peach-tree alone, but also attack the apricot, plum, almond, and occasionally the cherry-tree.

THE PEACH-TWIG BORER (ANARSIA LINEATELLA).

The adult of this insect is a small brown moth with wings expanding about ⅜ to ½ inch. It has a jaunty little head, reminding one of that of a quail in a miniature way. There are two distinct broods during spring and summer, and in some latitudes a later brood in the fall. As soon as the new growth appears the young larvæ commence to bore into the tender new twigs, the tips of which soon wilt, and upon examination the larvæ, about ¼ inch long, may be found burrowed into the heart of the tree just below the wilted portions. In the course of a month the larvæ leave the young twigs and spin cocoons, which they secure in a crevice in the limbs of the tree with a few cross-webs. These pupate and in about two weeks the second brood of moths begin to fly. After mating, the females deposit their eggs on or near the fruit. When the new larvæ hatch out, they immediately commence to bore into the fruit just under the skin and gradually work farther in as they grow older; thus the second brood are fruit-borers. Some of these leave the fruit before it is picked and spin their cocoons in the crotches and crevices of the trees, as did the first brood; others of the later brood bore into the bark, spend their winter in the larval stage, and so are ready to operate on the young growth directly it appears in the spring. I think this irregularity of habit depends greatly upon latitude and atmospheric conditions. The loss resulting from the attack of this insect in some districts is enormous, hundreds of tons of peaches, apricots, and plums being condemned as culls. Many car-loads are condemned after being carefully packed and delivered at points of distribution. When the egg or the young larva just hatched out is the only evidence of infection at the time the fruit is being sorted and packed, one can easily realize how hard it would be to guarantee a car-load free from infection.

Control.—The remedy adopted so far consists of winter spraying with lime-sulphur 1-10 just as the buds are opening, and arsenate of lead 3 lb. to 50 gallons of water when the new growth starts. To protect the fruit from the attack of the second brood of larvæ, spray with arsenate of lead 3 lb. to 50 gallons of water just about the time the moths commence to fly, which will depend somewhat on the atmospheric conditions of the season. In this latitude the moths are on the wing by the middle of July.

THE PEACH-ROOT BORER (SANNINOIDEA EXITIOSA).

The peach-root borer (*Sanninoidea opalescens*) is known as the western species, the eastern species being *Sanninoidea exitiosa*.* There is a slight difference in the abdominal markings of the adult insect. The moth is a clear wing, belonging to the family Sesiidæ. It has a wasp-like appearance, the males being black with narrowly yellow-banded abdomen, and almost entirely transparent wings. The females are much larger, the fore-wings bluish black and entirely covered with scales. The under-wings are transparent, while the abdomen is bluish black with a broad orange band about the middle. Moths hatched out in this district answer this description. The moth lays its eggs on the bark near the surface of the ground the latter part of July or the beginning of August. These hatch out in a few days and immediately commence boring into the bark in a downward direction. By winter they are from ½ to ¾ inch long, and have already eaten out considerable of the inner-bark tissue near or just beneath the surface of the ground. In spring they resume feeding, attaining a length of a little more than 1 inch long. Their presence underneath the bark may be easily detected by the gummy exudation mingled with brown granulated castings. By selecting one of the points of exudation and cutting in with a good sharp horse-shoeing knife, the channel in which the larvæ are working is easily found. Follow this down and the borer is soon found doing his best to girdle the tree. About the end of June, or a little later in this latitude, the larvæ crawl out to near the entrance of the excavation and spin a cocoon of silk covered with bits of chips and gum, and change to pupæ. In this stage they remain about two or three weeks; then emerge as moths ready to start a new brood. In cutting out the borers, one should avoid as much as possible cutting into the healthy bark, especially in a horizontal direction, as the borer may have left very little solid bark with which to maintain the life of the tree. Perhaps the best time to cut out borers would be June, when they are full grown and easier to find, before they pupate and the new moths fly. After cutting out all the borers and before replacing the earth around the tree, the following wash should be applied from the crown of the roots to 18 inches above the ground: One part lime-sulphur to 6 parts water, with enough fresh-slaked lime to thicken 5 gallons of the mixture to a good thick paint; into this stir thoroughly ½ lb. whale-oil soap and ¼ pint of carbolic acid or 1 lb. of coal-tar. When the paint has had time to dry on the trees, replace the earth, banking up 4 or 5 inches. This wash will also protect the roots from fungous rot, etc., besides making it very difficult for the young larvæ to penetrate.

In some sections the practice of fumigating the roots with carbon-bisulphide in order to kill the borers has been resorted to, to save the cutting of the trees; but is not very popular on account of the danger of killing the trees, which has often happened if the carbon-bisulphide was allowed to come in contact with the bark, or if the soil is too wet at the time or soon after the application. The peach-root borer is one of the most injurious insects attacking the peach and other stone trees, on account of its deadly work in the most vital part of the tree, where it works unseen; and often its presence is not even suspected until too late, when the tree wilts and dies as the result of the crown of the roots having been completely girdled.

Mr. McCubbin gave an account of the depredations of the fruit-fly in West Australia.

Mr. Boncquet: In regard to the root-borers of the peach, in Minnesota a few years ago the trees were troubled by rabbits, mice, and borers. One of the professors

* *S. exitiosa* was the variety bred in the Okanagan.

suggested the use of boiled linseed-oil, and burning it until it became sticky like tanglefoot. Aloes and carbolic acid were added to the mixture and the whole applied to the trees. It proved, I believe, an effective remedy.

Mr. Lyne: I might say that there are numerous washes in operation. Crude coal-tar has been proved effective.

Mr. Tom Wilson: I have tried coal-tar on sapling ash against rabbits; so far as I know, no harm resulted. We used to band holly-trees for half a foot.

Mr. Brittain: Asphaltum is being used largely now. It expands and contracts with the temperature and it is permanent.

Mr. Lyne: This has been experimented with, and I believe that, on occasion, injury resulted.

Mr. Kennedy: I never saw asphaltum used in the Santa Clara Valley, California.

Mr. Lyne: They used whale-oil also.

Mr. Brittain: They also use carbolic and limewash; with a system of "worming" the wash allows one to see the borings better.

Mr. Boncquet: When are the eggs laid?

Mr. Lyne: In July and early August.

Mr. Edwin Smith: Have you any notes on the eggs of *Anarsia lineatella* in fruit and the effect of cold-storage on them?

Mr. Lyne: Refrigerated peaches will come in and they will be pronounced fairly clean. If many crates come in at one time, the merchants unload at their own time. By holding the fruit thus many worms will hatch out.

The Chairman: We will now proceed to the next paper.

CUTWORMS AND THEIR CONTROL.

BY M. S. MIDDLETON, DISTRICT HORTICULTURIST, NELSON, B.C.

The cutworms in the Kootenay and other Interior points did practically no injury this year (1913) to crops. This is attributed to the larvæ having been parasitized last fall. It was almost impossible to find a cutworm this year, where last year they could be found in millions. It seems to be the history of all insect pests taken over a number of years that it is one of epidemics alternating with periods of comparative immunity, which is brought about almost wholly by parasitic attacks. These parasitic controls are of the greatest advantage in keeping down the ravages of all insect pests, and for this reason the study of the new entomology is not only interesting, but, I believe, quite practical at least in many cases. These periodical outbreaks are always liable to appear, however, and we should always be prepared to combat them to the best advantage. We find that the cutworms were extremely bad during the seasons of the years 1900, 1906, and in 1912. They gradually worked up to this epidemic stage and in the year following were extremely scarce.

Although we are able to control the outbreaks of cutworms quite satisfactorily, there still remains a great field for further investigation and experimentation work. It was my intention to have carried on a number of experiments this summer, with the object in view of finding out, if possible, more effective means of controlling these pests, but owing to the immunity this year was unable to do so. We must all feel pleased that the cutworms were scarce and the cause of very little loss this year. I shall have to confine my remarks to the results I obtained last year while dealing with possibly the greatest scourge of cutworms which the Kootenay District has had since the advent of agriculture. The worms were so thick that the ground could be actually seen moving with them, and they could be heard feeding on the clover. In parts the clover-crops were completely devoured by the cutworms. Various controls of poisoned baits were used with varying results.

I found them doing injury to nearly every cultivated plant, including green grain. The greatest losses were caused in the vegetable-gardens and in young orchards, where the worms of the climbing species would crawl up the small trees and eat out the upper buds. This did not result in the killing of the trees, but the

growth would be so checked and disarranged that the trees had to be cut back or reset. In cabbage, turnip, and tomato fields they were very destructive, and in strawberry-beds a great deal of harm was done. In the strawberries the injury was principally on the roots and crowns of the plants. I really think that we have little idea of the great damage done by the cutworms.

Amongst the most common species that we have in the Interior are the red-backed (*Paragrotis ochrogaster*), the greasy (*Agrotis ypsilon*), the variegated (*Peridroma saucia*), and the zebra caterpillar (*Mamestra canadensis*). Some twelve species of cutworms are known in Canada, and our list might be extended to include the following: Yellow-headed (*Hadena arctica*), spotted (*Noctua c. nigrum*), brown (*Nephelades minians*), W. marked (*Noctua clandectina*), common striped (*Euxoa tessellata*), white climbing (*Carneades scandiens*), spotted legged (*Posograti velusta*), and dingy (*Feltia subigothica*).

The poison bait is possibly the best all-round material to control the cutworms. It is best made by using 1 lb. of paris green, 50 lb. of bran, and about 3 lb. of sugar. The best way to make it is to first moisten the bran a little to cause the paris green to adhere better to it; then add the paris green and mix well. Where large quantities are needed a canvas sheet is a good article upon which to mix the paris green and bran thoroughly. Just spread the moistened bran on the canvas, sprinkle over it the paris green, and mix well by the use of a garden-rake. Then add the sugar as sweetened water. The bait should be considerably sweeter than the plants which the worms are feeding upon. I found much the best results where the bait was well sweetened and well poisoned. Apply the mash fairly dry, just so that it will almost crumble through the fingers, and apply it in the evenings. About 25 to 50 lb. of the mixture should suffice for an acre of vegetables and fruit. Where fruit-trees only have to be treated much less will be required. It is a wise precaution here to keep the mixture well away from the trees or plants, as the arsenic in the mixture will cause scalding of the bark, and in many cases I have seen trees girdled by the effects of the paris green. In the case of fruit-trees and larger plants the use of tanglefoot has given good results in some districts. Just place about an inch strip of the tanglefoot around the trunk of the tree about 6 inches to 1 foot from the ground. This has to be watched closely, lest the dust from cultivating or windstorms might destroy its effectiveness. There was a sticky tree-oil sent out by a Tacoma firm, but it did not give good results, as it melted with the heat of the sun and then crystallized. Banding the trees with cotton batten has also been used to very good advantage. Just take a tuft of batten and fasten it around the trunk of the tree, leaving it loose on top, and the worms will not climb over it. Running chickens in the orchard is also very effective in controlling the cutworms.

Cultivation methods can also be practised to assist considerably in controlling the cutworms. If we could have all weeds and plants cut down each fall a great many of the larvæ and eggs would be destroyed. Cover crops where they have to be left over winter as a protection crop is often bad for harbouring the cutworms, and when ploughed under in the spring the worms flock to the trees in the orchard. By sowing the cover crops a little later the eggs might be destroyed before the cover crop is sown. The worms make their appearance about the middle of May and are bad until the end of June. They then pupate and the egg-laying should be over about the end of August. If these dates are correct the cover crops and protection crops could be sown late in August, when they would not be likely to harbour the worms.

ECONOMIC ORNITHOLOGY.

BY LIONEL E. TAYLOR, F.Z.S., M.B.O.U.

The best definition I can find of "economic ornithology," the title of this paper, is given by Mr. T. S. Palmer in the U.S.A. Year-book of the Department of Agriculture of 1899: "Economic ornithology has been defined as the study of birds from the standpoint of dollars and cents. It deals with birds in their relation to agricul-

ture, horticulture, trade, and sport; it treats of species important to the farmer, the fruit-grower, the game-dealer, the milliner, and the sportsman; in short, it is the practical application of the knowledge of birds to the affairs of every-day life. The study of the relations of birds to agriculture is as intricate and difficult as it is broad and comprehensive. Its successful prosecution presupposes not only an accurate knowledge of classification, distribution, migration, and habits, but also an acquaintance with the measures which have been adopted for the preservation of useful or the destruction of noxious species. Theoretically, it should be one of the first branches of ornithology to receive attention; in reality, it has been one of the last."

It is as regards the value or otherwise of birds to the farmer that I wish to direct your attention. I do not claim to be an entomologist, and I do not intend to analyse the food of insectivorous birds to try and prove that this species feeds on harmful insects, and that one on useful ones. Such information is readily obtainable from the numerous valuable bulletins on the food of birds published by the Biological Survey of the U.S.A. Government and other publications. I am anxious rather to plead for a more general treatment of the subject; that is, from the standpoint of the balance of nature, to show how important it is to consider the matter from this point of view and how easily one can be led astray by ignoring it.

To first of all take the case of seed-eating birds, there is no doubt that almost any one can be shown to be a destroyer of millions of weed-seeds during the course of a year. Many people naturally think that it would only require a sufficient number of certain birds to entirely rid them of certain weeds. Nature, however, has made other arrangements by which the weeds shall remain in spite of even plagues of birds. A certain number of seeds are permitted to pass through the birds' alimentary system unharmed. Professor Collinge has recently shown this in the Journal of the Board of Agriculture, where he gives the result of experiments in the germination of seeds from bird-excrement as follows: 133 weeds of 7 species were grown from 38 droppings of the house-sparrow, 52 of 7 species from 38 droppings of the greenfinch, and 96 plants of 9 species from 50 droppings of the bullfinch; proving that seed-eating birds are greater distributers of weed-seeds than is generally supposed. He finally says: "We cannot rely on weeds being kept down by birds, and the expense of cultivation to eliminate weeds is, I believe, not reduced in the slightest by the action of birds." In conclusion, he states that he cannot regard seed-eating birds as beneficial.

Now, to take the case of insect-eating birds, I cannot do better than quote from a review of recent literature on the subject of economic ornithology in the *Auk* for January, 1913, where the writer compares the value of controlling insect pests by natural and artificial means. He says: "There is a deep-seated and persistent (because founded on love of ease) idea that if natural enemies are only sufficiently encouraged and protected, crop-production free from the annoyance of insect pests will be assured. That this is a dream impossible of fulfilment is evident from the fundamental interrelations of living things. Natural enemies have developed because there was an excess of individuals of certain species that could be destroyed without any permanent decrease in the numbers of the species as a whole. In creatures with annual or shorter generations, as is the case with most insects, all but an exceedingly small proportion of the offspring must die without participating in reproduction; the way of their taking-off is unimportant. They may as well be eaten as to starve, dry up, or freeze. Whatever happens to the supernumeraries, a small but fecund minority remains. The average number of the species is about the same from year to year. If there is an excess of individuals, under natural conditions, that satisfies the demands of enemies, without endangering the existence of the species. What an overwhelming excess of a species there must be where we give over acres or hundreds of acres to pure cultures of its favourite food-plant. No wonder there are constantly recurring outbreaks with which natural enemies are unable to deal." He further states: "When we consider the degree of insect-control necessary to the commercial

success of crops, it is evident that man must invariably depend upon his own efforts. He must know about natural enemies, give them all due credit and protect them, but we must beware of exaggerating their services. People are only too easily misled in this direction, but the final result of too great faith in natural enemies is disappointment. Let the student of natural economics see, therefore, that blame for such disappointment cannot be justly laid upon him."

These remarks are particularly applicable to fruit-growing, where hundreds of acres are planted in a confined area, furnishing an inexhaustible food-supply for scores of insect pests, which can only be controlled by artificial means and not by natural enemies, because the balance of nature has been upset. To think that any number of birds could control an attack of aphides, for instance, where ideal conditions for the feeding and propagation of these insects has been created, is out of the question. One has only to think of Huxley's well-known calculation, that one single aphis would produce in ten generations "more ponerable substance than five hundred million of stout men; that is, more than the whole population of China." It is obvious that if the birds left one or two individuals in the orchard, and nature had not provided the means for destroying them, either natural or artificial, there would not be much orchard left.

It is without thinking of these matters, certainly through want of knowledge, that there are more periodical agitations here and in many other parts of the world for the introduction of exotic birds as aids to the farmer. The question of the Government introducing birds into this Province is brought up at Farmers' Institute meetings and other meetings every year. As you are probably aware, the Government sanctioned the introduction this year of several hundred songbirds from England by the Natural History Society of Victoria. I protested as strongly as I could to the Government against such importation, but without avail, and the birds have since been liberated. The birds introduced were the European skylark, goldfinch, linnet, robin, and blue-tit.

I will now briefly put before you some facts in connection with the economic standing of these birds in other countries. In the U.S.A. Year-book of the Department of Agriculture for 1898 there is an instructive article by Mr. T. S. Palmer, of the Biological Survey, on "The Danger of Introducing Noxious Animals and Birds," in which the author says: "Species usually regarded as beneficial in their native home, such as the European skylark, green linnet, etc., are likely to prove injurious in new countries. The skylark confines its injuries mainly to turnips, eating the seed soon after it is planted. The green linnet is similarly injurious to grain. In New Zealand linnets have spread to other islands five and six hundred miles away." The following is an extract from a leading article in the *Morning Post* on the subject of the "Plague of Birds": "The green linnet is a serious nuisance to the hop-grower, settling on the hops just as they get ripe and tearing them to pieces in order to extract seed, until the whole ground is green with the fallen petals. The common or green linnet is usually regarded as a quite harmless eater of weed-seeds, but in the eastern counties he often takes heavy toll from the grower of turnip and radish seed, settling in great flocks upon the fields as the crops ripen and while they are being harvested. One Norfolk grower this autumn stated that the linnets had taken at least one-third of one of the crops of swede-seed which the weather had forced him to leave out rather longer than usual." In the guide to the birds in the British Museum (Natural History), written by Mr. W. R. Ogilvie Grant, now head of the Bird Department and one of the leading ornithologists of the day, the following occurs under the description of "Blue Titmouse" (*Parus cæruleus*): "Insects and their larvæ form the principal food, and though this diet is supplemented in autumn by fruit, the small damage done in gardens is compensated for by the wholesale destruction of insect pests." Professor Collinge, in the above-mentioned work, quotes the following charge brought against the blue-tit by one of his correspondents: "Ten years ago I should have said that a blue-tit was deserving of all protection, for its food consisted almost entirely of insects. Recently, however, I have had

cause to change my opinion of this bird, for it now picks holes in apples, pears, and strawberries, and causes a considerable amount of damage."

Mr. Collinge, however, speaks in favour of the blue-tit in spite of all that has been chronicled against it, although he arrives at this conclusion by balancing its good and its evil deeds. This is all very well for the ordinary farmer, but it is cold comfort for the fruit-grower.

From the above it will be seen that there is a chance of the skylark, linnet, and blue-tit being injurious to the farmer, and the general opinion in all countries where the acclimatization of foreign birds and animals has been attempted is that it is not wise to introduce any birds or animals of whose characters there is the slightest suspicion. Personally, I think it very unwise to introduce any seed-eating bird, such as the goldfinch and linnet, and I cannot see the object of introducing blue-tits into this country where we have several closely allied species of the same genus (*Parus*)—namely, the chickadee, already resident in enormous numbers in this Province.

In order to obtain further information on this subject, I wrote to Mr. J. Lewis Bonhote, secretary of the British Ornithologists' Union, a well-known authority on birds, asking for his opinion on the advisability of importing these birds into British Columbia. The following is Mr. Bonhote's reply: "*Re* the importation of the birds you mention, I am strongly against any such practice. Nature is so carefully balanced that one can never tell how far-reaching may be the effect of importation; in most cases, if not in all, where the imported species have thriven, the results have been bad, and the useful economic purposes for which the introduction was made have not been successful and many harmless and useful indigenous species killed off. To attempt, therefore, such a dangerous experiment for mere æsthetic purposes is, I should say, to run far too great a risk, and I would certainly advise you to oppose the suggestion as strongly as you can. To take the actual species you mention, it is difficult without knowing the country to give any definite advice; seed-eaters (goldfinch and linnet) are always risky, as, although in England those birds feed chiefly on the seeds of weeds in uncultivated districts, yet, if they did not find suitable weeds in Canada, they would soon turn their attention to the cultivated grain; where mustard is grown in any quantity, as in the fens of Cambridgeshire, the linnets do considerable damage. The robin is practically harmless, but he is a terrible fighter, and would be nearly sure to dislodge more useful native insect-eating birds. Beware of tits, especially in a fruit-growing country; they all attack the buds of fruit-trees, and also, though to a lesser degree, ripe fruit and many kinds of seeds. Larks seem to me the most harmless on your list, but, of course, they are largely seed-eaters, and I quite believe that they might do more than good. One has to remember that each country has its own fauna—which lives on each other—special flowers being fertilized by special insects, which in turn are kept in check by special birds. To introduce any strange animal, therefore, must upset the balance, and it is impossible to tell you what the effects will be. I cannot call to mind a single case of successful introduction, though there are many that have been harmful, and I am sure you would be well advised in opposing this suggested introduction as strongly as you can." This letter speaks for itself, and fully bears out my contention that there is an element of risk, and that the Government should not take any chances in allowing the importation of any foreign birds whatsoever.

The cause of all trouble where introduced animals and birds have become pests is the upsetting of the balance of nature. The reason for this was given by the Hon. John Cockburn, K.C.M.G., in a paper read by him on bird legislation in Australia at the Fourth International Ornithological Congress: "The equilibrium of life is less stable in a new country than an old. The limits of food-supply and natural enemies do not afford so rigid a check to propagation, and consequently any newly introduced form of life may, under favouring conditions, run riot throughout the land."

I think, from the remarks and quotations given, that you will agree with me that there is a chance of these so-called birds becoming a pest and upsetting the

balance of nature. Such being the case, it is the duty of scientific societies, such as this one, to protest to the Government against permission being granted to introduce any exotic birds into this country, either from æsthetic or economic considerations.

Mr. Tom Wilson: On the North Thompson the grouse is a destructive bird in orchards, as it attacks growing buds of trees. Pheasants are also a curse, and this is accentuated by the fact that they are not allowed to be shot except in season. I am a little opposed to the introduction of birds into the Province, and partly also to game birds.

Mr. Cunningham: In confirmation of Mr. Wilson's remarks, I wish to evidence the importance of destroying wild crab-apple on the Island and around Vancouver. These trees breed the oyster-shell scale. A few years ago I advocated this, but a great protest arose, accompanied by press writing. The extermination of wild crabs would materially affect the grouse, which feed on these trees. The fruit-grower was not considered.

Mr. McCubbin: There is also, I believe, a bounty on horned owls. These birds prey on mice and rats. They also destroy these game birds.

Mr. Tom Wilson: I recollect an instance when 75 per cent. of an orchard was girdled by mice and the man obtained good money for owls.

Mr. Taylor: This bounty on owls has since been removed. In regard to the mice question, in 120 acres a man had to replant 60 acres. This was not, however, the fault of the owls; the orchard was in poor shape. The starling in England is a fairly harmless bird. When introduced into Australia and New Zealand it began to feed on grapes, the natural food being absent. Cecil Rhodes in South Africa introduced the same bird. In six years it spread enormously and fed again on the grape. There is now a bounty on starlings in that country.

Mr. Creese: I must say a word to support the blue-tit. In England this bird feeds on woolly aphis and the currant bud-mite. It will also attack eggs of insects in winter.

Mr. Taylor: Quite true. Possibly 95 per cent. good and 5 per cent. harm; but to me there appears to be no object obtained in this country. The native chickadee belongs to the same genus and has the same habits; why not patronize them? Besides, the blue-tit may become dangerous.

Mr. Day: I quite agree with the folly of upsetting nature.

Mr. Winslow: Our Department in Victoria when asked for an opinion replied that, while we admitted the sentimental gain, we took the stand that the possible harm outweighed the possible good.

A member: Why not protest against the granting of permits?

Mr. Day: It is now too late to make any protest. We might draw up a resolution to present later.

It was moved and seconded, "That this Society, in view of recent researches into the economic value of introduced birds in other countries, disapproves of the practice of granting permits for the introduction of any exotic birds in this Province." Carried unanimously.

THE ECONOMIC IMPORTANCE OF CANADIAN IPIDAE.

BY J. M. SWAINE, DOMINION DIVISION OF ENTOMOLOGY, ASSISTANT ENTOMOLOGIST FOR FOREST INSECTS.

Among the Canadian species of the family Ipidæ (bark-beetle and ambrosia-beetle) are many of greater or less economic importance. Their destructive activities are along several lines in accord with their varied habits.

The bark-beetles breed in the inner bark or between the bark and the wood of healthy or dying trees. A few species prefer living trees; others prefer dying bark, but attack and kill green timber when in immense numbers; and still others are found almost solely in rapidly dying bark, or with a few species in bark that is dead and fairly dry; both coniferous and deciduous trees are attacked, but the former

are more subject to serious injury in Canadian forests. Those species which are able to kill healthy trees prove among the most destructive of forest insects. The genus *Dendroctonus* contains a number of species most injurious to coniferous trees. *D. piceaperda*, Hopk., in successful outbreaks, has killed an immense amount of the finest spruce timber in Maine and New Brunswick. This species is a constant menace to the spruce forests of eastern Canada, but does not appear to be concentrated at present in destructive outbreaks. *D. valens*, Lec., is commonly found in dying bark of spruce and pine stumps and logs, and, not rarely, is the primary cause of the death of trees. It is assisting *D. brevicomis* in killing bull-pine in the south-western part of this Province. In the timber attacked this season, and still green, *valens* is working in large numbers. It may be considered a destructive species in bull-pine in British Columbia.

An undescribed species of *Dendroctonus* breeds in immense numbers in the fire-injured timber of northern Manitoba, and has killed a small amount of jack-pine timber, mostly in the neighbourhood of the burns. *D. simplex* breeds abundantly in dying larch-bark from Manitoba eastward, and apparently kills many trees weakened by the larch sawfly.

An undescribed species of *Dendroctonus*, assisted by species of the genus *Ips (Tomicus)*, is apparently killing much fine white-spruce timber along the Athabaska River, above and below Athabaska Landing. This infestation has not yet been carefully investigated. *D. pseudotsugæ*, Hopk., breeds abundantly in logs of Douglas fir and western larch in British Columbia. It everywhere attacks and kills injured and weakened trees, and frequently kills considerable green timber.

D. monticolæ, Hopk., has killed much western white-pine (*Pinus monticolæ*) in the Sugar Lake region of British Columbia, and the outbreak is still spreading. This species also attacks and kills the black-pine in that district. *D. brevicomis* is destructive to bull-pine in British Columbia.

In the Princeton section an outbreak by this species has been running for three years and much valuable timber has been killed. The clumps of "red-tops" may be distinguished upon the mountain-side and in the valleys for many miles. The infestation is spreading rapidly and threatens the entire bull-pine stand of that region. The same trouble is appearing in other sections. *D. monticolæ* and *D. valens* are working in the same trees, and the former appears to be as destructive as *brevicomis*. *D. engelmanni*, *D. borealis*, *D. murrayanæ*, and *D. obesies* are variably destructive to spruce and pine in different parts of the Province. The habits of these and other ipid beetles of British Columbia are being carefully investigated.

Many species of the genus *Ips (Tomicus)* are abundant in dying bark of pine, spruce, and larch. Most species of this genus found in Canadian forests are important secondary enemies of trees, but are seldom found attacking green timber. There are, however, several important exceptions. *Ips balsameus*, Lec., is a serious enemy to balsam fir throughout Ontario, Quebec, and New Brunswick, and to a lesser extent is injurious to larch. Several species of the genus are injurious to pine and spruce in British Columbia and Alberta.

Polygraphus rufipennis, Kuby, and allied undescribed forms are everywhere important secondary enemies to pine, spruce, and larch. They are usually found in dying bark, but are apparently able to attack and kill healthy trees. Several species of *Phlœosinus* are locally injurious to cedars. A large number of species belonging to various genera are important secondary enemies, breeding in the bark of injured, weakened, and dying trees.

Certain twig-beetles of the genus *Pityophthorus* excavate and kill the twigs of various pines, and at times become sufficiently numerous to check seriously or even, rarely, to kill the infested trees. Such injury was common two years ago in southern Quebec to white and red pine; and in this season abundant on jack-pine in northern Ontario, and bull-pine in British Columbia.

Two species of this group are injurious to fruit-trees. The peach-tree bark-beetle (*Phlœotribus liminaris*) and the fruit-tree bark-beetle (*Eccoptogaster rugulosus*) are important pests in southern Ontario. The former breeds also in wild cherry in Quebec Province; but *E. rugulosus* does not apparently occur elsewhere in Canada.

The clover bark-beetle (*Hylastinus obscurus*, Marsh) cuts tunnels similar to those of true bark-beetles in roots of red mammoth alsike and crimson clovers, and is injurious in parts of Quebec and Ontario.

The deciduous trees of Canadian forests are less subject to injury by members of this family. Several destructive species found in the northern half of the United States have apparently not yet ventured to cross the boundary. We have many species, but, in the experience of the writer, few attack green bark.

Ambrosia-beetles, although belonging to the same family, have quite different habits. The adults bore round tunnels through the bark and into the wood. These tunnels are invariably stained dark brown or black by fungi which grow upon the walls. The eggs are deposited free in the tunnels (*Anisandrus* and *Xyleborus*) or in niches similar to those of the bark-beetles, cut along the tunnel-sides (*Gnathotrichus*, *Trypodendron*, *Pterocyclon*). The larvæ of these species enlarge the niches to elongate cavities, larval cradles, slightly more than their own length. Each species has invariably associated with it, growing in a dense layer upon the walls of the tunnel and larval cradles, a particular species of fungus. Several species of these ambrosia-fungi have been carefully studied by the writer. Under the proper conditions the conidia germinate readily and pass through the conidial cycle in about sixty hours.

Both beetles and larvæ feed upon the fungus. The larvæ of *Anisandrus* and most species of *Xyleborus* feed upon the fungus exclusively; and with the larvæ of all ambrosia-beetles, of this country at least, the fungus is a necessary diet. All our coniferous trees are subject to attack by species of *Trypodendron* and *Gnathotrichus*. Poplar, oak, birch, beech, maple, and alder are attacked by species of *Trypodendron*, *Anisandrus*, *Xyleborus*, and *Pterocyclon*.

The ambrosia-beetles do not, as a rule, attack sound trees in Canadian forests. They enter dying trees, or their parts, and recently felled logs and stumps, in which chemical changes have apparently rendered the sap more suitable to the growth of their fungi. With us their injury is only noticed in felled timber left out of water or in fire-injured stuff.

RESOLUTION RE QUARANTINE MEASURE.

"Whereas this Association at the annual meeting in Victoria last January did pass *unanimously* a resolution introduced by the Inspector of Fruit Pests, requesting the Dominion Government to enact such legislation as would prevent the importation of fruit and other vegetables from countries and Provinces infected with insect pests, bacterial and fungous diseases, not widely prevalent in this Province:

"And whereas the Dominion Government has admitted that the legislation requested may properly be enacted by the Provincial Legislature, and has graciously signified its desire that a Quarantine Act, with such provisoes as may be necessary to meet the peculiar conditions of this Province and the wishes of the people, as voiced by the Boards of Trade, Fruit-growers' Associations, Farmers' Institutes, this Association, and other public bodies throughout the Province, may be speedily enacted:

"Be it therefore *Resolved*, That this Entomological Society, in convention assembled at Vernon, B.C., in the month of July, 1913, hereby reaffirms its opinion that the legislation requested is necessary and expedient, and renews its appeal to the Provincial Government to bring down such legislation at the first meeting of the Provincial Legislature as will adequately protect the agricultural and horticultural industries of this Province from pests and diseases not widely prevalent in British Columbia."

Moved by G. O. Day, seconded by Lionel E. Taylor.

INDEX.

PAGE.

Acacia sphærocephala 8
Anarsia lineatella 34
Anisandrus 43
Aphides 31
Cherry-slugs 16
Claviceps purpurea 5, 7
Combination sprays 9
Cordyceps militaris 7
Cunningham, T. (Paper by) 24
Cutworms 36
Dasyscypha wilkommii 6
Davidson, J. (Paper by) 5
Day, G. O. (Paper by) 29
Dendroctonus 42
" piceaperda 42
" valens 42
" brevicomis 42
" simplex 42
" pseudotsugæ 42
" monticolæ 42
" engelmanni 42
" borealis 42
" murrayanæ 42
Eccoptogaster rugulosus 43
Economic ornithology 37
Empoasca mali 9
Empusa muscæ 6
Ergot fungus 7
Gnathotrichus 43
Hydnophytum formicarum 8
Hylastinus obscurus 43
Ips 42
Ips balsameus 42
Isaria 7
Larch-disease 43
Lime-sulphur 18
Lyne, W. H. (Paper by) 34
Middleton, M. S. (Paper by) 36
Nepenthes 8
Palmer, L. L. (Paper by) 31
Phallineæ 5
Phlœosinus 42
Phlœotribus liminaris 43
Pityophthorus 42
Polygraphus rufipennis 42
Pterocyclon 43
President's address 29
Pyrethrum 16
Ruhman, Max H. (Paper by) ..... 27.
Sanninoidea exitiosa 34, 35

PAGE.
Sprays, combination 9
Stinkhorn fungus 5
Swaine, J. M. (Paper by) 42
Taylor, L. E. (Paper by) 37
Tomicus 42
Treherne, R. C. (Paper by) 21
Trypodendron 43
Vegetable caterpillar 7
Wilson, H. F. (Paper by) 9
Winslow, R. M. (Paper by) 17
Xyleborus 43

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